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Vol. 147 SATURDAY, APRIL 26, 1941 No. 3730

SCIENTIFIC ADMINISTRATION IN NATIONAL AND LOCAL GOVERNMENT

THE attack on the Civil Service launched by Lord Percy in the House of Lords recently, is only one among many indications of disquiet about the efficiency of national administration in a democracy in times of peace as well as in the stress of war. It is not only from the national point of view, however, that the question of government and administrative efficiency is being raised anew. Just as in the national sphere we are being forced to consider the limitation of national sovereignty and even the transfer of certain powers to a federation if world order is to be established, so within the nation we are being forced to reconsider the units of local administration. The forces which in certain fields of public service were already making for regionalism have been powerfully reinforced by the exigencies of war. Under its influence and that of the regional organization developed for civil defence, the character of local government is being profoundly modified. Not only its efficiency but also its scope and character are coming in for reconsideration and development.

These circumstances give pertinence to a number of studies of public undertakings which have appeared in recent years. We have had, for example, "Public Enterprise", a series of studies of developments in social ownership and control in Great Britain, covering the Port of London Authority, the Forestry Commission, the British Broadcasting Corporation, the Central Electricity Board, the London Passenger Transport Board, the Post Office, and others, edited for the New Fabian Record Bureau by Dr. W. A. Robson. Mr. T. H. O'Brien's "British Experiments in Public Ownership and Control" is one of a new series of studies under a recent scheme promoted by the Institute of Public Administration, and confines itself to the Central Electricity Board, the British Broadcasting Corporation and the London Passenger Transport Board. Dr. W. A. Robson's "The Government and Misgovernment of London" is a further important contribution, while still more recently, in "Advisory Bodies : a Study of their Uses in Relation to Central Government", by the Oxford University Politics Research Group, we have a careful examination of an instrument to which much importance was attached by Lord Haldane in the Machinery of Government Report.

One of the most difficult questions, and one which is at the same time closely related to the problems of regionalism, is that of municipal trading, examined by Dr. Herman Finer in a recently published volume.* Concentrating his attention on the four main municipal undertakings—electricity, gas, transport and water—he discusses the various theoretical problems raised by municipal enterprise, a brief survey of the historical development of municipal trading being followed by an account of the legal framework.

The main interest of this study at the present time lies in those parts of the second book, concerned with factors in production, which deal with administrative organization and personnel and with the size of the undertaking, and in the concluding observations on the balance of deterrents from, and incentives to, efficiency, and the factors of success and their development which comprise the fourth book.

Dr. Finer's principal criticism of the administrative organization relates to the size of the managing committees. The large membership

* Municipal Trading : a Study in Public Administration. By Dr. Herman Finer. Pp. 432. (London : George Allen and Unwin, Ltd., 1941.) 16s. net.

is required because the committees in charge of undertakings are representative of the council, and the council representative of the electorate is not conducive to a high degree of responsibility. Control of public enterprise tends to be anticipatory, to avoid the errors which have been seen to occur in private enterprise. On the other hand, it is recognized that the greatest single decision which a committee can make is the choice of its technical chief. Upon his expertness, and, just as much upon his character as an administrator and vision as a business man, the solvency and service of the undertaking depend; and generally speaking the committee is regarded as responsible for policy, while the manager is responsible for administration and is given a free hand in the planning of development and the execution of policy.

The conclusion is reached that, with few exceptions, municipal undertakings in Great Britain are efficiently administered, but while the weak spot of anticipatory control is referred to, insufficient stress is placed upon the extent to which conditions to-day are demanding a more dynamic and creative type of administration. These demands are made both in the field of policy and in that of day-to-day administration, and the extent to which war conditions have revealed the shortcomings of those who are merely capable of routine administration, only accentuates a weakness which was already becoming apparent in local and national administration in time of peace. It will no longer be sufficient for municipal undertakings to demonstrate their capacity for routine administration. They must show now that they also possess wide vision and powers of innovation and creative development—the power to see the services for which they are responsible in terms of wider national needs, and the capacity to judge between conflicting views of the public interest in those services.

It is the great merit of studies of the character of Dr. Finer's survey that they bring to light inherent weaknesses and facilitate the provision of correctives. The healthiest single factor in the success of municipal undertakings, he points out, has been direct democratic control, and for this reason he would deprecate any reorganization of these utilities on the lines of the semi-public corporation, of which he is severely critical, owing to its remoteness from control by the consumer. The development of that task of adult education in citizenship, and particularly in the functioning of, and application of, democratic methods upon which the continuance of genuine and efficient local government really depends, is calculated in itself to stimulate the provision of both a better type of councillor and committee man, and the supply of officials of the highest administrative capacity.

The technical officers are of critical importance. They, after all, are members of a profession, and for all save the very exceptional men will be limited by the general standard of their profession, just as that standard from another point of view ensures the maintenance of a high standard of efficiency. It is a welcome sign that professional men are increasingly taking an interest in the wider horizons of their profession and in the relation to post-war reconstruction, as indicated by Sir John Orr's address to the British Medical Association, Prof. A. V. Hill's address to the Parliamentary and Scientific Committee (see NATURE, March 1, p. 250), and Dr. John V. N. Dorr's address as Perkin medallist of the Society of Chemical Industry on the engineer and his responsibilities to the world of to-day and to-morrow.

It is only as the scientific worker and other professional men no longer content themselves with the easy task of criticizing the routine and timidity of civil service administration, but accept their own wider responsibilities and attempt to make positive contributions to the development of administrators characterized by creative ability and the capacity to promote energetic and far-reaching projects, and seeing opportunities rather than difficulties, that we can hope for advance. The administrator, whatever his professional origin, who is to use his opportunities to the full and carry with him those whose vision is narrower and who are less willing to co-operate or to take risks, needs not only the assurance of professional tradition but also the inspiration of professional ideals. Much might yet be done, even in its present form, to raise the outlook and character of local government and administration and to stimulate co-ordination, regionalism and the reorganization of areas, if the technical officers in municipal undertakings had the support of a wide and generous outlook and understanding from their professional associations.

Among the suggestions which Dr. Finer advances for improvement in the efficiency of municipal enterprise is steadfast and determined attention to the selection of officers of all grades. He advocates a much severer probation, and that technical officers as well as the administrative and clerical staffs should be compelled to take some such course as that prescribed for the diploma of public

administration instituted at various universities. Those managing undertakings must learn to appreciate their strength, and also the weaknesses against which they must continually pit their determination, so that they may be equal to the even severer demands which the necessary co-ordination and reorganization of areas will involve.

The possibilities of interchange of staff mentioned by Prof. A. V. Hill in his address referred to above, should also be given serious consideration. If we could once more stimulate the exchange and movement of technical and scientific workers between Government departments, local authorities, the universities and industry itself, the advantages in creative work as well as administrative outlook and efficiency would be far-reaching, from the scientific, technical, social and national point of view. The value of thus stimulating creative thought and checking departmentalism should make well worth while the effort required to develop a uniform pensions scheme, calculated to assist and encourage mobility whether between Government departments, the local government services, the universities or even industry. Even if the attempt can only be made over a part of the field, co-operation between Government service and the universities as suggested by Prof. Hill is a promising line of advance. Moreover, the wider experience and outlook which flow from increased mobility should assist to throw up administrators of the type so urgently required. Local government services have in fact done little to implement the findings of the Hadow Committee, nor have such public corporations as the British Broadcasting Corporation, the London Passenger Transport Board or the Central Electricity Board realized the possibilities which are before them of handling staff problems so as to develop an administrative service free from even the defects for which the Civil Service has been criticized.

FORESTRY ADMINISTRATION

Colonial Forest Administration
By Prof. R. S. Troup. Pp. xii+476+32 plates. (London: Oxford University Press, 1940.) 35*s*. net.

FORESTERS throughout the Empire will be glad to learn through the publication of this book that Prof. Troup was just able to complete this important work, which it was generally known he had in hand, before being struck down by the illness which proved fatal; from the prefatory note we learn that it fell to Mrs. Troup and Prof. H. M. Steven to see it through the press. One can confidently say that no one, but Troup with his exceptionally wide experience and clarity of thought and expression, could have written it. For both presentation of subject and printing we have nothing but praise, and do not remember ever having read through a book of 450 pages on forestry which revealed so few points calling for criticism. There may be, however, one rather fundamental doubt about it, and that is whether, in view of the public for which the book is stated to be written, namely, probationers and officers of the Colonial Administrative Service, it is not too lengthy and too expensive. The cost and length will, we believe, prevent its purchase by a large number of potential readers who would find it of great interest and value; it is too good a book to be referred to occasionally in the library, and but for these difficulties should surely find a place on the private bookshelf of all foresters and others interested in forestry.

The preface explains how the subject-matter of a short course of lectures has come to be expanded to so solid a volume, but we feel that a significant amount of the more technical aspects of forestry, such as a discussion of the mean and current annual increment and details of working-plan procedure, could have been omitted, though their inclusion undoubtedly results in the presentation to the administrator of a more finished picture of forestry in general. As it is, it can confidently be asserted that no colonial administrator or forester can read the book without finding a great deal of useful information new to him, whilst some of the surveys, such as those on the effects of forest destruction and on the character and distribution of forests are masterpieces of skilful compression; the explanation of a working plan and sylvicultural systems is equally good. The book as a whole also answers extremely well the common query: "What does a forester do?"

The book is divided into two parts. Part 1 deals on broad lines with all the major heads of forestry, such as the influence of forest on climate, soil erosion, the effects of forest destruction and measures for protection, forest reservation, State control, etc. Part 2 takes the units of the Colonial Empire in turn and describes the major points of policy and administration in each.

A few points noted during perusal of the book may be mentioned. In Section (? lecture) VI, the account of cover crops for soil conservation is perhaps not altogether up to date and the impression is wrongly conveyed that *Tephrosia candida* is a small tree similar to *Leucæna glauca*. The importance of growing the most suitable variety or strain of seed requires mention either in this Section, as for *Prosopis glandulosa*, or in that on plantation work (XII) as for teak.

In Section VIII, a point that might have been more stressed is that the clearing of good forest in the tropics by no means necessarily gives good agricultural land.

In Section IX, as an important point in practice, rather more might have been said on one of the indirect effects of uncontrolled grazing, especially of goats, and that is the intensive lopping which always accompanies it, leading to selective extermination of fodder species. More might have been said of the experiments of recent years under the head of seasonal closure when at least part of an area must be kept open at any given time. So important is the warning that undue multiplication of stock must be prevented before it is too late that one would have liked to see it more heavily underlined; unfortunately the usual history is that no effective action is taken by the administrator on the forest officer's continued complaining until control has become far more difficult and unpopular than it would have been had the trouble been nipped in the bud. Declaration of grazing policy is a sound measure, but critical examination of the Central Provinces, India, the example quoted, would reveal its very weak spot of accepting a very bad *status quo* in overgrazed forests.

In Section XI, recent very successful extensions of the *taungya* method in thickly populated tracts, often with the primary object of meeting villagers' needs even for tree loppings, might have been referred to as a possible pointer for future development.

In Section XII, the data for employment given by forest operations are useful as also the demonstration of the magnitude of the demand on the forest of factory or mining activities. It is pointed out that where denudation is rampant the pinch first comes in a shortage of fuel: this might have been developed with the common picture of the fields being deprived of cattle manure because this is the only available substitute for wood fuel. In Section XIII, on forest exploitation, the author repeatedly emphasizes the importance of pushing the use of second-class timbers, a step the need of which is almost universally felt in the more extensive forest tracts and must be given the closest attention. In Section XIV, dealing with ownership, etc., one would have liked some indication of the extent to which laws concerning forest control on private land have actually been acted on.

We feel that a note of warning on the risks involved in settling forest villages would have been in place in Section XV. Instances could be quoted where, for whatever reason, the forest work which it was intended to do through their agency has not been properly done and the land occupied has ultimately been excised from the forest to form a centre of all the usual troubles over grazing, lopping, felling and fire damage that are characteristic of squatters' settlements in the middle of a forest. The figure given for the annual shifting cultivation area in Nigeria will come as a surprise and a shock to many.

In Section XVI, it is pointed out that the South African gold mines need the produce from 100,000 acres of plantation annually, but one misses an explanation as to how this huge demand is being met at present.

Section XIX, dealing with administration, includes a note of warning which will be endorsed by many practising foresters, against undue specialization in the earlier stages of development. The first duty of a young or small department is to give the forests in its charge really effective protection and simple conservative management.

Section XX deals with education and research. Every forest officer who has been in India knows how much of the executive work is done by the trained subordinate staff, particularly the rangers, and Troup finds repeated occasion to rub in the importance in various directions of building up a similar staff in the Colonial Dependencies.

The accounts in Part II of the forest policy and position in the several colonies give a historical account of the forest administration leading up to the current policy; this is followed by a summary of the procedure for reservation, which is frequently influenced by differences in form of ownership of the land, and concludes with area statistics. These accounts, of which there are as many as twenty, vary in length from 3 to 10 pages, not necessarily in proportion to the area of forests, and will be found exceedingly useful for reference.

Finally, there are five appendixes which are also very welcome as collecting information hitherto not readily available on forests and water supply, forestry in relation to tsetse fly control, legislative and administrative action taken in regard to protective forestry, colonial mining laws and timber rights, and a list of colonial forest laws.

The forty-four half-tone reproductions of photographs used to illustrate the text are very well selected and of a standard one has come to expect of Troup and the Oxford University Press.

H. G. CHAMPION.

THEORY OF KNOWLEDGE

The Analysis of Knowledge

By Prof. Ledger Wood. Pp. 264. (London: George Allen and Unwin, Ltd., 1940.) 12*s*. 6*d*. net.

THIS work on the theory of knowledge has distinct merits. It is well arranged, well written and discusses all the subjects that should be discussed. The author deals with sense experience and memory, perceptual knowledge of 'things', of our own selves and other persons, the generalized knowledge of science and the knowledge implied in judgments of value. However, the book as a whole is disappointing.

In treating of perception the author criticizes the 'sense-datum' school of writers on grounds that certainly do not apply to Broad or Price. His own theory seems to be just the sense-datum theory with a slight change in terminology. He takes no account of what Gestalt psychology has to say about the objects of experience, and does not mention the important discussion in Blanshard's "Nature of Thought". He emphasizes at the beginning that all thought is referential, pointing to something beyond itself. One would suppose that this implied that relations are as real as any of the terms they relate, yet in Chapter vii he maintains that universals, including of course relations, are concepts, in the sense of being mental entities having no reference to anything beyond themselves. Worse still, in the last chapter he states a correspondence theory of truth, which implies a realist view of universals, since, as he says, truth is a property of propositions and since every proposition contains at least one universal term.

The best and most original feature of the book is the chapter on valuational knowledge, though it is confined to ethical judgments. The author perhaps makes undue use of the ambiguity of the term 'ideal', but he deserves credit for realizing that, however naturalistic a theory of knowledge may be, it cannot exclude value judgments, and for an ingenious method of including them.

If Prof. Wood could be induced to accept a realist view of universals (under the guidance of Peirce, Russell or Whitehead) to clear up some minor inconsistencies and to consider what Köhler and Blanshard have to say about facts of experience (only authors resident in his own country have been named), there are here the elements of a valuable theory.

AIR NAVIGATION

The Observer's Book on Astro-Navigation

By Francis Chichester. Part 1. Pp. 103. Part 2. Pp. 83. (Observers' Books, Nos. 3 and 4.) (London: George Allen and Unwin, Ltd., 1940.) 2*s*. 6*d*. net each.

IT is commonly thought that the determination of the position of a moving aircraft by means of astronomical observations is a difficult and complicated business. Actually, the principles involved are of extreme simplicity, and the working out of the observations takes at the most a few minutes with the aid of the *Air Almanac* and suitable altitude-azimuth tables to provide the solutions of the spherical triangles.

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To draw the position line, any convenient position for the aircraft, somewhere near its estimated position, may be assumed. The position line will be independent of the assumed position. The surface navigator has been tied for too long to his 'dead reckoning position, which has no special virtue. In air navigation, an assumed position is adopted such that the altitude-azimuth tables require no interpolation. With the aid of the *Air Almanac* and the *Astro-Navigation Tables*, both prepared by the Nautical Almanac Office for the Air Ministry, the reductions are reduced to their simplest possible forms.

In these two small volumes, by an experienced air navigator, the methods and principles involved are explained in clear and simple language. Specimen pages from the *Air Almanac* are reproduced and their use is described. A number of hypothetical observations (for which the astronomical

data can be obtained from these pages) are fully worked out to illustrate the methods, according as observations are made of stars, the Pole star, planets, the sun or moon. The principles of the bubble air sextant are explained and the methods of observation are described.

These volumes are eminently practical and can be strongly recommended to all navigators. They can be read in an hour or two and should help to dispel the mistaken belief that there is anything mysterious or complicated in the principles and methods of air navigation. H. S. J.

THE TEACHING OF BIOLOGY

(1) Animal Biology

By Robert H. Wolcott. (McGraw-Hill Publications in the Zoological Sciences.) Second edition. Pp. xxi + 649. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 24*s*. 6*d*.

(2) Human Biology

By Prof. George Alfred Baitsell. (McGraw-Hill Publications in the Zoological Sciences.) Pp. xv + 621. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 26*s*.

(1) THE basic themes around which this course in zoology is built are: life as a chemico-physical basis and life as a manifestation of metabolism. The choice of title is a happy one, for the course here devised is truly a biological one, and should cause most authorities responsible for general university degree courses in Great Britain to think whether their teaching is not too much based on systematics and type systems, at the expense of animal physiology.

Having got a course in animal biology (as opposed to zoology) it is not a very far cry to general biology; since Prof. Wolcott has proved possible, and even desirable, a course in animal biology up to university degree standard, it should be no more difficult to devise a course of the same standard in general biology—a course of study which is practically non-existent in Great Britain. Indeed, even in this avowedly "Animal Biology" the author has recourse to plants in such topics as tropisms, photosynthesis, alternation of generations, etc. Maybe the day will come when students in all universities can take a degree course in general biology, instead of the present botany and/or zoology courses. Until that day comes, there will perforce be a lack of good teachers of biology in schools, with the consequent backward condition of the teaching of the subject. It is surely a reflection on our system of teacher training that even now many teachers of biology in schools have either not qualified in the subject or are specialists in botany or zoology, and consequently either biased or ill-informed, or both.

At this stage, therefore, we would strongly recommend all students of zoology and certainly all teachers of biology to read Prof. Wolcott's book. Though he does not ignore zoological 'types' altogether, he does, on the other hand, lay special emphasis on general, comparative and economic aspects under such chapter headings as: energy, protoplasm, metabolism, plants and animals, behaviour, Protozoa and diseases, tissues, fertilization, reflex action, anthropoid apes and man, structure of organisms, developments, ecology, animal organisms in health and diseases, and so forth.

(2) Prof. Baitsell's book strikes an even more novel note, basing an introductory study of biology on a study of man himself. The author's reason for such a course is sound, being based on "the increasing realization . . . that the majority of students beginning work in college biology were, inherently, far more interested in acquiring knowledge about the human organism than they were concerning any other living species". We believe this to be true in the majority of cases.

Here again, plant biology is utilized in the study of certain aspects of the subject. The text is by no means medical. It is a real biology with man as the main 'type', though others are frequently called upon, for example, the development of the frog, chick, other mammals, in leading up to growth and reproduction in man.

There are an interesting chapter on disease and a very extensive appendix of ninety-three pages which will do much to prevent the student's thoughts being devoted solely to man. The appendix is unusual in being arranged alphabetically in encyclopædia fashion. It deals with such diverse subjects as acetylcholine, Amœba, Aristotle, biology of medicine, Brownian movement, colloids, diffusion, germ plasm, taxonomy, history, pneumonia, etc.

Both these books are by American biologists and therefore might with advantage be consulted by British students and teachers, since biology is an academic and cultural subject of study and has made greater progress in the United States than in Great Britain. But the live British biologists are aware of our shortcomings and will welcome the aid offered by such as these books.

Kungl. Svenska Vetenskapsakademien:
Förhistoria, Grundläggning och Första Organisation. Av Bengt Hildebrand. Pp. xv+672. Noter, Bilagor M.M. Pp. v+673–886. (Stockholm: Kungl. Svenska Vetenskapsakademien, 1939).

IN these two volumes, Dr. Hildebrand gives an account of the inception, foundation and early years of the Royal Swedish Academy of Sciences, which is now two hundred years old. Already in the seventeenth century the spirit of research in the natural sciences was afoot, and the tendency to do away with Latin in place of the worker's national language was gaining ground. There was, however, a strong utilitarian bias in scientific work. The Royal Society of London and the Academy of Science of Paris showed the way to pure research. The foundation of these and later that of the Academy of Science of Russia prepared the way in Sweden. A few attempts to found learned societies failed, for the universities still were dominated by the dead languages, but in 1728 the Royal Society of Sciences was founded in Uppsala. About the same time the capital saw the start of academies of music, painting and literature, and in 1739 the Academy of Science was founded on the model of the Royal Society and the French Academy of Science; two years later it received a royal charter.

Among the founders was Linnæus, who became its first president. The early bias of the academy towards economic problems was not maintained beyond the beginning of the nineteenth century, and up to that time much attention had been paid also to work in mathematics and natural science. In 1813 agriculture founded its own academy, and under Berzelius the Royal Swedish Academy devoted itself more and more to natural science, giving up humanistic and practical studies.

Dr. Hildebrand traces in detail all these changes and the background against which they took place, and he gives a long account of the work of all the founders, as well as the original constitution and descriptions of the library and museum. There is an exhaustive bibliography on all aspects of the work.

R. N. R. B.

Analytical Processes:
a Physico-Chemical Interpretation. By Dr. T. B. Smith. Pp. viii+470. (London: Edward Arnold and Co., 1940.) 18*s*. net.

DURING the past ten years, many important advances have been made in physical chemistry, and it is not surprising, therefore, that a new edition of Smith's "Analytical Processes" has now made its appearance. This new edition incorporates recent developments, and some sections of the first edition dealing with fundamental relationships have been dropped.

To appreciate this book fully, the reader must be fully conversant with the basic principles of physical chemistry, and the volume is therefore of particular value to senior students or to those making physical chemistry their special study. The author's object is to give full scientific explanations of the theories underlying analytical processes, since only those who have a thorough knowledge of such theory can ever approach, with any hope of real success, the many new problems arising in the examination of minerals and of new industrial products. Further, such knowledge is essential when sources of error in analytical processes have to be elucidated, minimized or removed.

This authoritative and advanced treatise is indispensable not only to those who are engaged in a university course, but also to technical chemists whose duties lie in industrial chemical analysis.

Practical Histology and Embryology
By Dr. Nellie B. Eales. Pp. xi+111. (London: Macmillan and Co., Ltd., 1940.) 3*s*. 6*d*. net.

THIS little book provides an excellent guide to practical work for first-year students in histology and vertebrate embryology. Dr. Eales is an experienced and successful teacher and knows well the pitfalls that lie in the way of the beginner. The simplest methods and a small number of fixatives and stains have been chosen out of the bewildering variety that are at the disposal of the more advanced worker. Directions are given for preparing simple histological injections and for the elementary technique of mammalian embryology, both of which are usually omitted from the first-year course. It may perhaps be suggested that the simplification of methods might perhaps have been carried a little further with advantage; that rough hand-cut sections might have been substituted oftener for the more elegant products of the microtome. Many beginners, and even some more advanced students, have great difficulty in relating the two-dimensional picture presented by a microtome section to the three-dimensional structure of a tissue or an embryo. Sections cut, however inexpertly, by the student himself, do help him over this difficulty.

Very few slips have caught the eye of the reviewer, but Canada balsam is not crystalline (p. 6), nor are teeth "epidermal products" (p. 63).

W. T. CALMAN.

Modern Diagnosis
Edited by Sir Humphry Rolleston and Dr. Alan Moncrieff. ("The Practitioner" Handbooks.) Pp. 286. (London: Eyre and Spottiswoode (Publishers), Ltd., 1940.) 12*s*. 6*d*. net.

THE editors are to be congratulated on the choice of the twenty contributors to this volume, which consists of two parts, the first dealing with clinical diagnosis and the second with laboratory and special diagnosis. With the exception of an article specially written for the book by Dr. C. J. C. Britton on the technique of simple blood examinations and methods for collection of blood, all the contributions have previously appeared in the *Practitioner*, but have been revised and brought up to date. Although the work covers a wide range of subjects including neurology, dermatology, cardiology, pædiatics, gastro-intestinal disease, diabetes and chronic rheumatism, it makes no claim to discuss the whole field of medicine, but deals only with those subjects in which diagnosis is most difficult.

The book, of which the text is liberally interspersed with illustrations, is admirably suited for the general practitioner and senior student.

THE STUDY OF LAKE DEPOSITS

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LAKE deposits have proved to be of interest in various ways. They present convenient material for the study of the process of sedimentation and of the initial stages of sediment metamorphosis. They remain for long periods uninfluenced by erosion, weathering and other disturbances, and preserve in stratigraphical sequence such animal and plant remains as resist decomposition, and also the inorganic portion of the parent material. They record in varying completeness and detail the biological history of lakes and the climatic conditions in which sedimentation occurred.

In general the natural evolution of a lake is towards greater productivity associated with changes in the species composition of the phytoplankton[1]. In some cases this evolution may be recorded in the deposits in considerable detail. For example, striking changes accelerated by sewage pollution, occurring in Lake Zurich have been recorded and can be accurately dated in the deposits[2].

Climatic conditions may be recorded in a general way by the presence of some organisms, for example, plankton and tree pollen, which are indicators of definite climatic types. Late glacial sediments sometimes record climate in greater detail. De Geer[3] has successfully substantiated the hypothesis that the laminations (varves) in late glacial clays represent annual cycles in the deposition of silt carried by glacier streams into still water. Thicker layers of coarser particles correspond to floods produced by rapid summer melting, and the finer layers, alternating with these, represent winter sedimentation. Careful and detailed correlation of sections of varve deposits from a great number of localities in Fenno-Scandinavia led to the establishment of a detailed climate chronology for the late-glacial period of ice recession in that region. It was possible to connect this with recent time by the study of the deposits of Ragunda lake in northern Sweden. These deposits present a fairly complete series of annual laminations from the time when the ice sheet retreated northward from that lake until 1796 when the lake was accidentally drained. This period, which the latest estimates put at close on nine thousand years, may indicate the order of magnitude of the period during which post-glacial sedimentation has continued in the British Lake District and Scottish Highland lakes.

In Great Britain little work has been done on these interesting lines of investigation until the last few years, during which the deposits of Windermere and other waters of the Lake District have been studied by the Freshwater Biological Association. In an earlier communication[4] the value of echo-sounding apparatus for the survey of certain types of lake deposit was demonstrated, and now this is followed by an account of work on cores of Windermere deposit obtained with new apparatus. In the initial stages of this work, one of us (C. H. M.) obtained cores with a simple steel pipe operated from a boat and driven in by a ramming weight. These cores showed the zonation of laminated clays and organic layers, indicated in core *A*, Fig. 2, and the diatoms (examined by W. P.) exhibited an interesting succession. We are grateful to the Royal Society for a grant enabling this work to be continued with improved apparatus.

THE CORE-SAMPLER

In spite of its simplicity, an open-ended sampling pipe used for obtaining cores has disadvantages which have been previously discussed by Jenkin and Mortimer[4]. Some other types of core-sampling gear were briefly described and the working principles of an improved apparatus (designed by B. M. J.) were outlined in the same communication. This apparatus in modified form has now been successfully operated in Windermere, and cores of up to 6·5 m. in length have been obtained under 65 m. of water.

The core-sampler, illustrated diagrammatically in Fig. 1, is operated from a pontoon held in position by four anchors and consists of the core-cutter (*A*,*A'*), extension tube (*B*) and turning gear (*C.C*). The core-cutter, previously described in more detail[5], consists of an outer casing in the form of a tube, part of which is cut away and replaced by a flat face-plate, and an inner half-tube (the cutter). This is supported on a shaft, the rotation of which causes the cutter to pass out through a slit at the side of the face-plate, cut into the deposit and

enclose a sample 1·25 m. long. As this operation is performed after the core-cutter has been lowered to the required depth in the deposit, and as the cutter follows a horizontal circular path into undisturbed deposit, distortion of the sample is reduced to a negligible minimum. The practical operational details are concerned with ensuring that the core-cutter is exactly at the required depth in the deposit, and with cutting out the sample and removing it for examination.

A sounding wire (*D*) passes over a pulley at the top of a vertical metre scale. The sampler is suspended by the hook (*E*) at the end of the cable from a crane. The extension tube (*B*), which is 15 ft. long, is connected at one end to the core-cutter and carries the turning gear at the other. The turning gear consists of a pair of skew-gear wheels, one of which is keyed to the vertical shaft which passes down through the extension tube and is coupled with the core-cutter shaft. The other wheel is mounted on a short horizontal shaft, which carries a grooved disk (*C*) at either end. Metal blocks (*F*,*F*), attached to the free ends of a wire bridle, fit into notches, one in either disk. Turning the disks counter-clockwise, with the blocks in the notches, winds the bridle on, rotates the shaft and turns the inner tube of the core-cutter back inside the casing (open position *A*).

Sampling Operation

The sounding wire is paid out until the weight rests on the bottom. The pivoted swing-arms (*G*,*G*) are locked by the trip-bolt (*H*) with their free ends embracing the sounding wire, but allowing it to pass freely between them and through the middle loop (*I*) of the turning gear bridle, which is also held between the ends of the arms. The sampler is then lowered by the crane until the swing-arms, which slide down the sounding wire as a guide, are felt to hit the stop (*J*) which has been so adjusted that the bottom of the core-cutter is at the mud surface at this point. Penetration into the deposit is measured on the metre scale by a pointer (*K*) fixed to the sounding wire, and is halted at the required depth.

To close the core-cutter and take the sample, a messenger weight slides down the sounding wire, strikes the trip-bolt (*H*), releasing the swing arms which are pulled to the open position (G′,G′) by rubber bands. The sounding wire is now pulled up and, as the loop (*I*) rests on the stop (*J*), this withdraws the bridle, turns the disks clockwise and closes the core-cutter (*A*′).

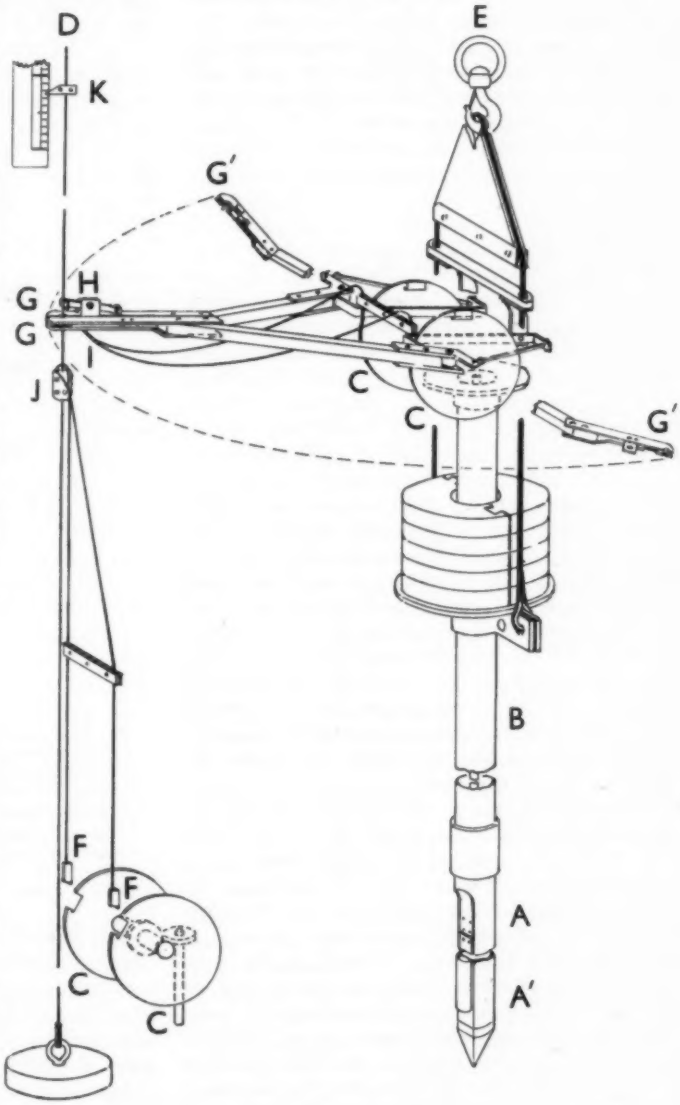

Fig. 1.

DIAGRAMMATIC ILLUSTRATION OF THE DEPOSIT SAMPLER

When raised to the surface, the weight of the sampler is transferred from the crane to two derricks and slings by the help of which it is laid face-plate upwards on a plank fixed along the side of the pontoon. After washing the outside, the core-cutter is opened by turning the disks counter-clockwise, exposing the sample on the face-plate. A sheet-iron tray is inserted between this and the sample, which is then removed for examination.

The above operation was repeated at each sampling station to obtain an overlapping series of samples, each 1·25 m. long. The weight of the sampler alone (200 lb.) was usually sufficient to penetrate the upper 2–3 m. of deposit. For deeper samples, up to 360 lb. of extra weight was added in the form of half-disks of lead, held together by dovetail projections and placed at the top of the extension tube above *B*. In work to date, the factor limiting the lengths of core obtained was the length of the extension tube.

THE CORES

With the apparatus described above a survey has been conducted of the bottom deposits of the North Basin of Windermere. Nineteen cores have been obtained in water depths ranging from 3 to 65 metres, in addition to the cores taken with the steel ramming tube. Fig. 2 shows two typical cores, from shallow and deep water respectively.

The soft, often semi-liquid surface muds are underlain by a varying thickness of firmer, dark-brown organic deposit, here called the brown mud, beneath which is a thick layer of pink laminated glacial clay, which is present in both deep and littoral regions. As was expected from the echo-sounding records[4], the total deposit, both organic mud and clay, is much thicker in deep water than in the littoral region. In cores from shallow water of less than 10 m., in the western bays, the lowest deposit is a fairly coarse gravel, which is at the base of the laminated clay, about 4 m. below the mud surface. In the deep central region, the total length of core obtained (6 m.) just included the upper layers of the laminated clay; but cores from the southern end of the North Basin, taken in about 30 m. of water, showed that here the laminated clay is 0·7–0·9 m. thick, and is underlain by a stiff, blue-grey, unstratified clay containing gravel and fragments of shale in its lower layers. It is probable that these gravels rest on the rock surface and, with the unstratified lower clay, probably represent late glacial deposits formed during the period when the lake basin was occupied by ice. Above them lies the laminated clay, the laminations of which consist of alternate layers of coarser and finer material. These are almost certainly varves, formed in the later period when only valley glaciers remained, and water occupied the present lake basin. In several cores the upper part of the laminated clay contains layers of grey silt with organic remains (diatom shells, moss plants, and in one core, leaf fragments), in contrast to the clay itself, which is practically devoid of organic remains. These organic layers appear to represent transitory periods during the retreat of the ice, when conditions in the lake were more favourable for plant growth.

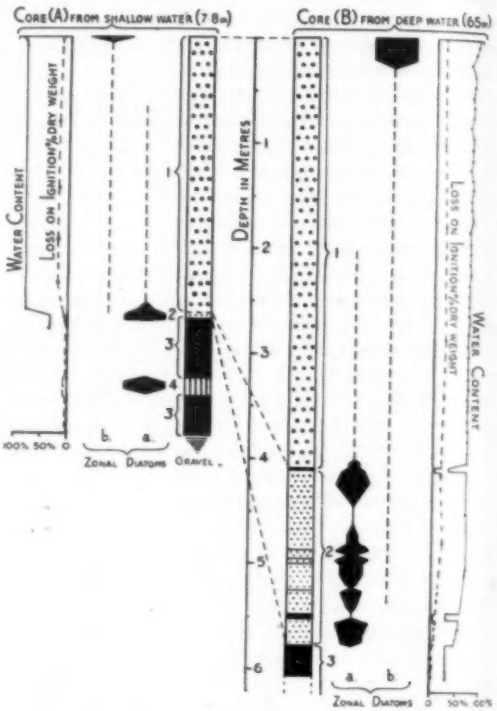

Fig. 2.

DIAGRAM OF A TYPICAL CORE FROM SHALLOW WATER AND ONE FROM DEEP WATER OF WINDERMERE, SHOWING THE DISTRIBUTION OF TWO ZONAL DIATOMS, AND GRAPHS OF WATER CONTENT AND LOSS ON IGNITION.

1, Brown Mud; 2, Zone of narrow clay bands; 3, Laminated glacial clay; 4, Diatomaceous layer in clay. Zonal diatoms: (*a*) *Melosira arenaria* cf. var. *hungarica*; (*b*) *Asterionella gracillima* + *A. formosa*. (*a* and *b* are not represented on the same scale.)

The deposits above the clay represent the Post-Glacial sediments, and it seems probable that, at least in deep water, they present a complete record of sedimentation over that period. In deep water, immediately above the laminated clay, there is a zone of 1·5 m. in which narrow bands of pink unlaminated clay are separated by brownish-grey organic deposits. These narrow clay bands show considerable local variation, but the thickest two

(1-4 cm.) are fairly constant in level in all cores from the deep area of the North Basin. All these narrow clay bands fade out laterally, and do not appear in the shallow water region, where this zone is represented only by a layer of brownish-grey silt, 5–10 cm. thick. The brown mud is 2·5 m. thick in shallow water, increasing to 4·0 m. in deep water. It is very uniform in appearance from top to bottom, and more organic than the silts between the narrow clays, but like them contains frequent narrow black or dark green layers of chlorite. In the delta region of the River Brathay, the largest river entering the lake, the brown mud is much thicker than elsewhere, and a core 5·4 m. long consisted entirely of this type of deposit.

Water content and loss on ignition are indicated in Fig. 2 for two typical cores. In the surface ooze a rapid fall occurs in water content, which was nearly 90 per cent at the surface and about 78 per cent at 30 cm. From this point downwards in the brown mud there was a gradual, somewhat irregular fall to about 70 per cent just above the clay. The density of the brown mud varied from 1·06 at the surface to 1·24 at the bottom. Variations in density may be attributed mainly to variations in water content, as the density of the dried brown mud was close on 1·6 from the top to 4 m. As might be expected, there was a sharp discontinuity between mud and clay. The top of the laminated clay was of fairly uniform water content (34–38 per cent) and density (1·70) in different regions of the lake. In the stiff unstratified blue clays, mentioned earlier, the water content fell to 24 per cent and the density rose to 1·97. Details of the distribution of loss on ignition may be seen in Fig. 2. Although irregular variations between 19–23 per cent occurred in the brown mud, there was no significant difference between top and bottom of this layer, but much lower values were found in the organic layers associated with the clays. The value for the clay was 3 per cent, which probably represents combined water. Loss on ignition in the brown mud and other organic layers may be taken as an index of organic content, as the error due to combined water can scarcely have been greater than 3 per cent.

Comparison of Cores with Echo-Sounding Records

Cores were taken at or near positions for which echo-records obtained with a Husun recorder were available. Many of these records not only showed an echo from the floor of the lake, but also one or more echoes below this at distances of up to 13 m. below the mud surface. It was suggested[4] that these echoes represented reflexions from density discontinuities, such as might be expected to occur at mud-clay or clay-rock interfaces. It is now possible to compare the level of the top of the clay in the cores with the level of the first echo below the mud surface in the corresponding echo-records.

The simplest conclusion from this comparison is that the first echo below the mud surface comes from the top of the laminated clay or from the uppermost of the narrow clay bands in cores where this is well developed and more than 1 cm. thick. On this assumption, comparison between echo-records and eleven cores yields values for the velocity of sound in the brown mud which vary between $1{\cdot}54 \times 10^3$ and $1{\cdot}68 \times 10^3$ metres per second. This small variation indicates that the above interpretation of the echo-records is correct. The mean value $1{\cdot}6 \times 10^3$ metres per second or 1·14 times that in fresh water is comparable with velocities of longitudinal explosion waves found in clays and waterlogged glacial material[5]. If the velocity of sound in the laminated clay is similar to that found in the brown mud, the echo-records indicate that another density discontinuity, possibly a layer of gravel or rock, exists at 10–12 metres below the mud surface in the deep region of the North Basin.

Organic Remains in the Cores

Diatom shells are abundant in the brown mud, the organic layers between the narrow clay bands, and in some of the organic layers in the laminated clay. In addition, a deposit of almost pure diatomaceous earth, 25–30 cm. thick, was found above the laminated clay in Low Wray Bay. The diatom content of all the cores has been studied, and the results show that three main phases in the past history of the lake can be distinguished.

It should be recognized that two main factors have been concerned in modification of the environment in the lake since glacial times : first, climatic changes affecting the whole region, and secondly, changes in the lake itself produced by silting and other causes. The first marked discontinuity in the cores is that separating the surface ooze from the underlying brown mud. This discontinuity occurs at 20 cm. below the mud surface in deep water, and rises nearer the surface as shallower water is approached, until it is about 5 cm. deep in water 5 m. in depth. The diatom flora of the ooze is characterized by *Asterionella formosa* Hassall and *A. gracillima* (Hantzsch) Heib. which, with *Cyclotella Kützingiana* Thwaites make up most of the diatom population. At the base of the ooze layer there is an abrupt drop in the numbers of Asterionella, which in the underlying

layers becomes unimportant. According to Pearsall and Pearsall[7] a plankton dominated by Asterionella represents a late stage in the evolution of a glacial lake, and it is known that since the beginning of the present century there has been a considerable increase in the numbers of this diatom in Windermere, where the natural processes of evolution have been hastened by the increase in productivity consequent on sewage pollution. It is probable that this layer of ooze containing abundant Asterionella represents the deposit accumulated in the last fifty years or thereabouts.

The brown mud below the surface ooze has a very uniform flora, dominated by the plankton diatoms *Cyclotella Kützingiana*, *Tabellaria fenestrata*, Kütz., *T. flocculosa* (Roth) Kütz., and small littoral diatoms which are more abundant in the cores from shallow water. These species are abundant in all the diatomaceous layers, and, in numbers, make up the greater part of the diatom population throughout the cores.

On the other hand, the large and conspicuous diatom species show a marked zonation. The brown mud in all the cores is characterized by *Gomphonema geminatum* (Lyngb.) Ag. and *Pinnularia major* Kütz. These, especially the former, become less abundant with increasing depth, but there is no pronounced discontinuity in the brown mud. A very marked change occurs below the topmost narrow clay band, and in the corresponding narrow band of silt above the laminated clay in the littoral region. Here, most of the large species, except the two just mentioned, increase considerably in numbers, and two species which are absent or rare in the brown mud, namely, *Melosira arenaria* Moore *cf. var. hungarica* Pant. and *Campylodiscus noricus* Ehr, become abundant. This type of diatom assemblage is constant throughout this zone immediately above the laminated clay, and in the diatomaceous layers within the laminated clay. It therefore appears to be associated with the conditions under which glacial clay was deposited. It is interesting to note that workers on the sediments of Crystal Lake, Wisconsin, found that the lowest diatomaceous layers contained species which may be identical with those of the lower deposits of Windermere. It is possible that the brown mud of Windermere may have been laid down during the period since the early Boreal, while the deposits associated with the clays may have accumulated during the period of ice recession.

Unfortunately, pollen is very scarce in the deposits, and no satisfactory time-correlation can yet be made. The only layers containing appreciable quantities of pollen are the peat bands which occasionally occur in the soft deposits of the narrow clay zone. In the lowest of these layers, the pollen is practically all Pinus, while several layers towards the top of this zone contain oak, birch, alder and hazel pollen. This would seem to indicate deposition in Boreal and Atlantic times respectively, but the sediments associated with the lower layers contain a diatom flora similar to that of the supposed late-glacial silts occurring in the laminated clay. In the present state of our ignorance of the ecological requirements of diatom species and considering the fragmentary nature of the pollen figures, it is not possible to date the deposits with any certainty. It is possible, however, that measurements of the varves in the laminated clay may indicate some correlation between these and the time-scale established by De Geer from the Swedish and other varves.

Mr. D. J. Scourfield has examined the cores for animal remains, which were fairly frequent in the muds but apparently absent in the clays. Rhizopod tests and Cladocera fragments were frequent at all levels, while parts of insects, particularly Chironomus, and remains of small mites were occasionally found. By far the most abundant remains were those of Bosmina while three other planktonic Cladocera, Daphnia, Bythotrephes and Leptodora, and a considerable number of littoral forms belonging to the family Chydoridæ, were present. The same species occurred in all the cores in the brown mud, in the organic layers between the narrow clays and in the organic silts within the laminated clay. Although the remains are not sufficient to allow quantitative estimates to be made, it is concluded that the Cladoceran population has shown little if any change since glacial times, as all but one or two of the species recorded are living in the lake to-day. The absence of Daphnia valves and headshields and copepod remains in the cores is striking in view of their dominance in the zooplankton at present. This may perhaps be due to differences in rates of decay.

The main conclusions of this research are as follows: a successful method for raising undisturbed cores from the bottom deposits of lakes has been developed. The examination of cores so far obtained confirms the value of the echo-sounding machine as a means of providing data on certain types of lake deposit, and discloses a part of the climatic and biological history of Windermere.

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EXPLOSIVES*

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Nature of an Explosive

An explosive is a store of chemical energy in liquid or solid form which can be rapidly converted into heat and thence into mechanical energy. The explosive products must be gaseous, either wholly or in part, because the heat energy of solid or liquid products is not directly available for doing work by expansion. It is a popular fallacy that an explosive is an unusually rich store of energy. The fact is, however, that with sufficient air petrol is, weight for weight, capable of doing nearly eight times as much work as nitroglycerine, which is one of the most powerful of explosives; but nitroglycerine does its work much more swiftly, disrupting and pushing away its surroundings in a fraction of a second.

There are several ways in which chemical energy can be stored to form an explosive. For example, we can mix a combustible material like sugar with an oxygen-rich compound such as potassium chlorate. A far more perfect apposition of combustible and oxygen is secured, however, when both are suitably combined into a single chemical compound. But this combination is a peculiar one, in that the combustible and the oxygen are only loosely or indirectly associated in the molecule, usually through the intermediary of some relatively inert atom such as nitrogen, as, for example, in ammonium nitrate. This is, however, not the only way of storing up chemical energy to form an explosive compound. Any compound is a store of chemical energy if a rearrangement of its constituent atoms is possible which is attended by the evolution of heat; and if the rearrangement can occur swiftly with the formation of gaseous products, then the compound is an explosive. Thus the dissociation of acetylene into soot (solid carbon) and molecular hydrogen liberates heat, and acetylene has long been recognized as an explosive gas, particularly when compressed. We can, most conveniently, effect this compression chemically, that is, by making use of some of the chemical energy stored in acetylene. Thus the hydrogen of acetylene is easily replaced by metals such as copper, silver and mercury. The resulting compounds are solids, so that their chemical energy is concentrated into a far smaller volume than in acetylene gas itself. These acetylides are violent explosives, which decompose into soot and a highly heated gas of metallic atoms. In this case it is the resolution of the acetylene triple bond into the single bonds of soot which is the source of the heat energy.

There are other kinds of atomic arrangements which can serve as stores of easily released chemical energy. For example, although the dilute hydrogen peroxide of commerce is harmless, the pure liquid compound is explosive and decomposes readily into steam and molecular oxygen. Pure ozone, especially in the liquid or solid state, is an even more violent explosive. In each case the removal of an oxygen atom from the molecule requires the expenditure of much energy, but this is more than balanced by the heat evolved by the subsequent union of two such atoms to form a molecule of oxygen. Another atomic grouping where, on explosion, the main source of heat energy is furnished by the combination of like atoms to the molecular state is the triazo, $-N{=}N{\equiv}N$, group. Hydrazoic acid, HN_3, is an explosive liquid which readily forms a series of explosive metallic salts, of which lead azide is much used in the explosives industry.

An example of a class of compound in which the heat energy liberated on explosion results partly from the union of a combustible with an oxygen atom and partly from the formation of a molecule from like atoms is furnished by the fulminates. These are metallic salts of fulminic acid, $H{-}O{-}N{\equiv}C$, of which the best known is mercury fulminate, $Hg(ONC)_2$. On explosion, an atomic rearrangement takes place to yield as sole explosion products carbon monoxide, molecular nitrogen and mercury.

Sensitiveness

The sensitiveness of an explosive reflects its stability, being a measure of the energy required to dislocate the arrangement of the atoms in its constituent molecules to such an extent that they tend to relapse into a more stable configuration rather than to return into their original positions. It is difficult, however, to obtain an absolute measure of this 'least initiating energy', as it may be called, and in practice comparative tests must suffice. The results are sometimes conflicting; thus, nitroglycerine is less sensitive to a hammer blow, but more sensitive to heat than lead azide. Recent advances in our knowledge of crystal and

* From a lecture at the Royal Institution delivered on February 11.

molecular structure and of the nature of the chemical bond, seem to offer a fair prospect of a better understanding of the energy relationships involved in initiating the explosive process, at least in those compounds which are crystalline and of simple molecular structure, like, for example, the acetylides and the azides.

When an unconfined explosive is ignited by a flame, one is struck by the fact that, with certain few exceptions, explosives respond in one of two very different ways. Thus, match compositions, nitroglycerine, guncotton, blasting gelatine, cordite and gunpowder burn quietly, some more quickly than others, with flames of characteristic colour. Picric acid, trinitrotoluene and the aromatic nitrates in general burn sluggishly with a sooty flame. In striking contrast to this quiet burning is the behaviour of most of the acetylides, azides and the fulminates, which explode with great violence and set up intense shock waves when ignited. A closer examination reveals that this violent explosive process is preceded by a short period during which an initially slow rate of burning rapidly accelerates until the violently explosive stage is reached. In the case of burning, the energy needed to start decomposition in the hitherto unaffected portion of the explosive is handed on as heat from the burning zone to the adjacent unconsumed layer, which is thus ignited, and so on from layer to layer throughout the explosive. On the other hand, the succeeding violently explosive stage is due to the setting up, as the result of a rapidly accelerating rate of burning, of a steep-fronted sound wave which travels through the explosive at a high uniform speed. The intensity of this wave is so great, approaching 150,000 kgm./cm.^{2}, that the explosive at the wave front may momentarily be heated, by adiabatic compression, to a temperature of the order of 10,000° C., so that the resulting explosion is propagated hand-in-hand with, and maintains the intensity of, the shock wave in its passage throughout the explosive. In traversing an inert medium, such as air, this intensity of course decreases rapidly; nevertheless, the shock wave may still be capable of effecting explosion, even though attenuated by passage through a considerable air gap.

Detonants

The process whereby explosion is effected by a shock wave is known as detonation. An explosive which, even when unconfined, burns rapidly to detonation may be called a detonant. The shock wave is usually known as the detonation wave. Its velocity lies between 3,000 and 9,000 metres per second, and is related to that of sound in the same medium; hence, each explosive has its own characteristic and constant rate of detonation. The detonants, of which lead azide and mercury fulminate are the best known representatives, play a vital part in the use of modern high explosives.

Ability to burn to detonation is not necessarily associated with a high degree of sensitiveness, nor is it evidence of high energy contents of the explosive, as is sometimes supposed. For example, both nitroglycerine and cordite are roughly four times as powerful as mercury fulminate or lead azide. The explanation lies rather in the nature of the explosion products of such detonants, which are for the most part unable to dissociate appreciably, so that the chemical energy is transformed into heat in a single step instead of relatively slowly, by a succession of stages.

Propellants

The large class of explosives which burn quietly when unconfined may be further subdivided into propellants and the so-called high explosives, according to their behaviour when ignited by flame in a strong enclosure. A propellant, like gunpowder or cordite, merely burns. If it is non-porous and uniform in texture, like cordite, the propellant continues to burn from layer to layer at much the same uniform rate as when unenclosed, while a porous substance, like gunpowder or a partially gelatinized smokeless powder, burns at a less uniform rate because the accumulating pressure forces hot gases into the pores and thus increases the rate of burning. Under similar conditions a high explosive, after a more or less prolonged period of burning of somewhat uncertain duration, eventually detonates.

As the name implies, the function of a propellant is to propel a selected object in a desired direction. It is essential that the pressure of the explosion gases on the projectile should neither vary abruptly nor stress the gun unduly. At the same time the maximum permissible pressure should be continually exerted on the projectile and, to avoid waste, the charge must be completely consumed before the projectile arrives at the muzzle. These demands are met by a proper choice of the area-to-weight ratio of the propellant. For example, the cordite in a rifle cartridge consists of some fifty rods each about as thick as a darning needle. In a big gun, however, where the projectile takes much longer to arrive at the muzzle, the rods may exceed one inch in diameter.

An explosive which is liable to burn to detonation when confined as in a gun, is quite useless as a propellant. Should detonation occur, the gas pressure suddenly rises with such rapidity that the projectile cannot move fast enough to keep it within bounds, and the gun bursts and shatters

into many fragments. Such disasters, or 'prematures' as they are sometimes called, were at one time by no means rare, and were due to the use of propellants of an unreliable nature. The possibility of a premature occurring with a modern high-class propellant like cordite is so remote as to be negligible. This does not imply that a propellant cannot be made to detonate like any high explosive, but rather that it will not do so under the conditions of its use in a gun.

High Explosives

In contrast to the propellants, the tasks which a high explosive has to perform are such as to require that its energy be made available in the shortest possible time. This can only be achieved by causing the explosive to detonate. If the gases were liberated slowly, as with a burning propellant, they would have time to open up weak places in the confining surroundings and then expand through these openings between the obstacles, instead of breaking up and flinging them away. For example, if the explosive charge in a shell were only to burn, then the slowly rising pressure would merely push out the fuse and the gases would escape through the fuse hole, leaving the shell intact. In the case of detonation, however, the gas pressure rises so quickly that there is no time for the inertia of the more easily removed obstacles to be overcome before the surroundings as a whole have been subjected to pressures which they cannot withstand. Hence when the shell-filling detonates, the shell walls are broken up into fragments which are pushed outwards with high velocity by the blast of the expanding gases of detonation. Similarly, a slab of guncotton, even though unenclosed and merely laid on a steel rail, will sever this on being detonated, but would leave it unharmed if the explosive were merely to burn.

When the manufacture of nitroglycerine had been established as a cheap commercial process, the problem of how to detonate it and thus unlock its energy to the best advantage became a pressing one. The solution was found in the discovery that the detonation wave in mercury fulminate, placed in contact with nitroglycerine, could set up in it a fresh detonation wave with a velocity characteristic of this medium.

Whilst the more sensitive high explosives, such as blasting gelatine and dry guncotton, can be detonated without fail in this manner, others, like moist guncotton and the aromatic nitro-compounds, especially when cast or highly compressed, are uncertain in their response to the effects of even relatively large amounts of detonant, being often merely broken up into fragments and scattered. The difficulty is overcome by interposing between the detonator and the main insensitive explosive a few grams of a high explosive which will respond with certainty to the action of the detonator, and then pass on its own detonation wave to the main body of the insensitive explosive. This intermediate explosive is generally known as the 'gaine.'

The choice of a high explosive is governed by the kind of work it will have to do, and by the treatment to which it is likely to be subjected before use. As shell fillings, only explosives which are highly insensitive to shock and friction can be used with safety; otherwise detonation may occur before the fuse acts, or even before the shell leaves the gun barrel. Also, the gaine explosive, and still more so the detonator contents, must be so packed and supported in the main body of the shell filling that they too can withstand with certainty the rough handling of being fired from the gun. Finally, when the filling does its work, the shell should break up into swiftly moving fragments of the most effective size, and not be merely split into a few large pieces or completely pulverized. If nearly all the chemical energy became available immediately on detonation, as is the case, for example, with lead azide, the shell would be broken up into powder and fragments too small for effective flight, and the explosive is said to be 'brisant' or shattering. On the other hand, if the chemical energy is transformed into heat by a succession of steps as, for example, where such easily dissociated molecules as steam and carbon dioxide form the bulk of the explosion products, the shell fragments are likely to be too large; an effect to which a low velocity of detonation may also indirectly contribute. Finally, in order that the fragments should move away with high velocity, or that the shell should do as much damage as possible on bursting after penetration into an obstacle, the explosive should have high chemical energy contents and yield only gaseous products. These requirements can best be met by mixing together two or more explosive compounds, a procedure which may have, among others, the advantage of enabling costs to be reduced. Amatol, a high explosive consisting of a mixture of trinitrotoluene and ammonium nitrate, was introduced as a shell filling during the War of 1914–18; it was cheap and proved remarkably successful.

The high explosives used for blasting in quarrying and mining can be sufficiently sensitive to respond to a detonator without the added complication of an intermediate gaine, because the treatment which they receive in the course of transport, handling, and in the final packing into the shothole, is mild compared with that which a shell filling has to withstand. Here again, the

properties of the explosive must suit the work in hand. For example, in tunnelling through hard rock, a shattering and powerful explosive will serve best by breaking up the rock into small pieces easily handled for removal. On the other hand, for quarrying out large blocks of stone or in coal mining, where 'small stuff' represents waste, explosives are used which are comparatively slow in their action. Owing to the danger of coal dust and firedamp explosions, so called 'safety' explosives have been introduced for use in coal mining. These are slow-acting high explosives in which are incorporated substances like crystal soda which, by absorbing heat, prevent the temperature of the explosion flame from rising sufficiently to ignite coal-dust and methane-air mixtures.

OBITUARIES

Prof. William Bulloch, F.R.S.

PROF. WILLIAM BULLOCH, emeritus professor of bacteriology in the University of London, whose death occurred on February 11, was a bacteriologist of world repute and the historian of bacteriology. He took up the science of bacteriology in its early days and lived to see it reach its modern importance. In these early days there were but few masters, but he made it his aim either to study with them or make himself familiar with their ideas and technique, and with Koch, Salomonsen, Metchnikoff, Ehrlich and Roux he maintained an intimate friendship.

William Bulloch was born in Aberdeen in August 1868 and studied at the University there, taking his M.B., C.M. in 1890 and afterwards studying in several centres of learning on the Continent (Leipzig, Paris and Vienna). He was a brilliant student and was awarded many academic prizes and honours. Among the more important appointments which he held were that of assistant professor of pathology, University College, London, where he came into contact with David Ferrier and Victor Horsley; and bacteriologist at the Lister Institute, where he was associated with Lord Lister, of whom he became a life-long friend. In 1897 he was appointed bacteriologist to the London Hospital, to which he remained faithfully attached for the rest of his scientific career.

His great ability, his wide knowledge of his subject, and his integrity, soon established Bulloch as one of the foremost authorities on bacteriology in Great Britain, and for this reason he was invited to fulfil many important positions of trust. Thus he was chairman of the governors of the Lister Institute, an original member of the Medical Research Committee (Council), a member of the Government Committee on Foot and Mouth Disease, a member of the Committee of the Beit Memorial Trust, president of the Section of Pathology of the Royal Society of Medicine, honorary librarian to the Royal Society of Medicine for many years, and honorary fellow of this Society in 1940, honorary member of the Pathological Society of Great Britain and Ireland, etc. He also gave many important lectures in connexion with bacteriology.

Bulloch added much to the knowledge of his subject, and the more important of his published works covered such subjects as tuberculosis, bacteriological filters, studies in pathology, hæmophilia (with Fildes) in the "Treasury of Human Inheritance", the sterilization of catgut and diphtheria—its bacteriology, pathology and immunology, with others for the Medical Research Council.

I first met Bulloch some thirty-five years ago when a student. In the course of conversation I mentioned that I was about to go abroad to study, and he at once furnished me with the necessary introductions; the latter, as all friends of Bulloch know, acted as a magic charm to the portals of the great masters. Later, when I went to work in his Department at the London Hospital, I learned much of the man and his ideals. Bulloch was extremely conservative; in his own mind only the written word was authoritative, and us younger men he regarded somewhat as Bolsheviks in our views and methods. Thus some new procedure of technique we had devised or adopted would call forth the remark, "such methods are enough to make Pasteur and Koch turn in their graves". Yet in spite of this expression of doubt as to the success or usefulness of our investigations he would, a morning or two later when he came in for a friendly chat, present us with the latest literature on the subject of our research. The same interest in our progress was continued even when we had passed on from his Department. This generous disposal to us of his wide and accurate knowledge was in strong contradiction to his lack of interest in teaching medical students, which to him was of the nature of a necessary evil.

Perhaps Bulloch's outstanding characteristic was his highly developed critical faculty, at times devastating and even a little cruel when directed against imperfect or inaccurate work, only equalled by his intolerance of intrigue and advertisement. In his earlier days woe betide those who failed to come up to his standard, either in their writings or at a scientific meeting. But those who worked for him, even though his criticism was sometimes irritating, learned much that was to prove the foundation of their later successes.

Though brusque in manner, at home Bulloch was a genial and kindly host and liked to give play to his favourite hobby, the study of the frailties of the great men of his subject and of his immediate and humble associates. This gave him a fund of very amusing stories which he loved to recount with a clever mimicry, worthy of Coquelin himself, as a

French man of science once remarked. For this reason afternoon tea in the laboratory was a feast of wit and humour not to be missed. Strange to say, in spite of his cynicism, he was definitely a hero worshipper, and they were many and varied.

Bulloch had a prodigious memory and could give accurate references as to where and when most of the important papers on bacteriology had appeared. He had undoubtedly great influence in raising the standard of bacteriology in Great Britain to its present high level. Though his later years were clouded by long illness, he carried on to the very end his intense interest in all that pertained to bacteriology. Even the London 'Blitz' and the obliteration of the houses next door could not daunt him, as a recent letter I received from him, in the familiar purple ink, showed. We who had the privilege of working under him will long remember his ideals, his wit and his cheerfulness, and bear in our minds the picture of that short sturdy figure, with his carefully polished shoes, pipe in mouth, disappearing down the stairs after tea to commence in the library his real interests of the day.

J. McINTOSH.

Dr. C. B. Ticehurst

BY the death of Dr. Claud Buchanan Ticehurst of Saxon House, Appledore, Kent, on February 17, in a nursing home at Hastings, the science of ornithology in general and the British Ornithologists' Union in particular have suffered a loss which it would be difficult to exaggerate. It will be still more difficult to fill the gap which his death will cause in the publication of the Union's journal—the *Ibis*—of which he had been the successful and zealous editor since 1931. From his youth Ticehurst was what we might call a born field-ornithologist, but it was at Cambridge, where he was an undergraduate studying medicine at St. John's College, that ornithology came to be the leading passion of his life under the happy guidance and encouragement of Prof. Alfred Newton, whose Sunday evening gatherings were an inspiration and a joy to so many, including such famous ornithologists of the old days as Canon Tristram, the Godmans, Sclater, Wolley, Lilford, Gurney, Salvin, Taylor, Eyton, Wollaston and many others. Ticehurst was one of the many young men of those days who received, so to speak, the accolade; and had it not been for the strenuous calls on a country practitioner's time there can be little doubt that he would have risen to the highest level of ornithological fame.

As it was he established an international reputation, and not only found time to conduct the editorial business of the *Ibis*, only possible by constantly sitting up until the early hours of the morning, but also by clever manipulation of his scanty holidays found it possible to visit such countries as Norway, Portugal, Spain, the Balearic Islands, Holland, France, Yugoslavia, Albania, Egypt and Algeria; to say nothing of the important work he did in India when serving in the R.A.M.C. in the War of 1914–18. In all these countries he made collections of birds with the object of studying plumage changes, geographical distribution and migration. He also published papers in various scientific journals on the birds of Mesopotamia, Sind and Burma; was the author of one of the best county avifaunas—"The Birds of Suffolk"—and proved his sterling merit by writing a monograph on the willow-warblers (Phylloscopi) for the British Museum.

His untimely and much deplored death at the early age of sixty interrupted the work which he was carrying out in conjunction with Mr. Hugh Whistler on the birds of India, Burma and Ceylon.

Following in his father's footsteps, Ticehurst was a very skilful dry-fly fisherman; and by his death, if I may introduce a personal note, I lose a beloved and cheery companion by the banks of the Test. He was never so happy as when tempting (and quite successfully) the rather sophisticated inhabitants of that famous chalk stream (and the Kennet) with his father's self-tied flies, many years old as they were. Some of them had seen such long and faithful service that I think I must have known them by sight.

PERCY R. LOWE.

WE regret to announce the following deaths:

Prof. F. M. Andrews, professor of botany in Indiana University, on November 26, aged seventy.

Dr. James Balfour, F.B.A., the well-known economist, on January 18, aged eighty-eight.

Mr. M. R. Campbell, formerly principal geologist of the U.S. Geological Survey, on December 7, aged eighty-two.

Sir Charles Fielding, K.B.E., director-general of food production during 1918–19, on April 9, aged seventy-seven.

Prof. W. W. Ford, emeritus professor of bacteriology in the Johns Hopkins University, on February 10, aged sixty-nine.

Prof. W. C. Graustein, professor of mathematics in Harvard University, on January 22.

Prof. J. E. Guberlet, professor and member of the staff of the Oceanographic Laboratories of the University of Washington, aged fifty-four.

Mr. S. Henshaw, emeritus director of the Harvard Museum of Comparative Anatomy, on February 5, aged eighty-nine.

Prof. F. C. Jordan, professor of astronomy and director of the Allegheny Observatory, Pittsburgh, on February 15, aged seventy-five.

Dr. G. W. C. Kaye, O.B.E., F.R.S., superintendent of the Physics Department, National Physical Laboratory, on April 16, aged sixty-one.

The Right Hon. Lord Stamp, G.C.B., G.B.E., F.B.A., aged sixty, and Lady Stamp and the Hon. Wilfred Stamp, during a recent air raid.

Dr. J. P. Sutherland, emeritus dean of the Boston University Medical School, on January 24, aged seventy-four.

NEWS AND VIEWS

Agricultural Research Council: Sir Edwin Butler, C.M.G., C.I.E., F.R.S.

CHARGED as it was with the scientific supervision of the widespread organization for agricultural research which has been developed in Great Britain since 1911 and holding (as many may think unfortunately) but few of the purse strings directly, the policy of the Agricultural Research Council has been to guide and stimulate work in progress at research institutions, rather than to attempt control. As the late Sir William Hardy expressed it, "free" not "directed" research was what it desired to promote. In giving effect to this policy, Sir Edwin Butler proved himself an ideal secretary. An acknowledged leader in his own subject, mycology, he had, as director of institutions in India and Great Britain, gained a wide knowledge of the problems and the methods of the agricultural investigator. He quickly made himself familiar with the work of the research institutes and he visited them frequently. Nor was he ever an unwelcome visitor, since directors and members of staff alike soon found that in him they had a real friend, always ready to interest himself in their problems, always ready with helpful suggestions. To the Council the contacts thus established were invaluable, as were also his detailed descriptive reports. His conclusions could be accepted with confidence; they were marked by proofs of full understanding, careful weighing of evidence and absolute fairness. His personal qualities made him the best of colleagues and it was with great regret that, because of the verdict of his medical advisers, his resignation from the secretaryship was accepted. But this did not come until he had left behind him a permanent memorial of his tenure of office.

When, in 1935, Sir Edwin became its secretary, the Council was searching for a suitable estate on which to establish a field station for experimental work on farm animals; a number of estates was visited and when Compton was seen, Sir Edwin was the first to recognize its possibilities. After it had been acquired its development owed much to him, in particular the fine range of laboratories, and the homes for laboratory animals are largely the result of the care which he, in consultation with Mr. Dunkin, the director, bestowed on the planning of details. Members of Council and others who visit Compton in future must always associate these buildings with the name of Sir Edwin Butler, who watched over their construction from foundation to completion with unceasing care.

Prof. W. W. C. Topley, F.R.S.

PROF. W. W. C. TOPLEY, who now becomes secretary of the Agricultural Research Council, like his predecessor, holds a medical qualification, and like him decided to work for the advancement of science, rather than follow a professional career; but whereas Sir Edwin chose plant pathology as his special subject, it was on science as affecting animal health that Prof. Topley specialized. His name until now has been so closely associated with bacteriology in relation to human medicine that surprise may be felt by some to find him among the agriculturists. But he does not come among them as a stranger. Since the earliest days of the Agricultural Research Council, Prof. Topley has been a valued member of some of its committees on animal health. In 1939 he became a member of Council and he is chairman of the committee in charge of the particular investigation for which the Compton Field Station was, in the first instance, acquired.

It was with great pleasure that his colleagues learned recently that Prof. W. W. C. Topley was willing to accept the post vacated by Sir Edwin and that his qualities of initiative, drive, clear thinking and direct, convincing manner of speech when advocating a cause in which he believes have now been secured for agriculture. In the uncertain days which lie ahead, it is a comforting thought for all who have the progress of agricultural research at heart to know that as its Secretary the Council has secured the services of a man who has not only made outstanding contributions to science, but has also proved himself to be an inspiring leader of others. It may be that those primarily interested in medicine may regret Prof. Topley's decision, but let them not forget that in recent years it has become increasingly clear that the foundations of human health are deeply laid, that man's physical well-being depends in no small degree on the health of domestic animals, on the properties of cultivated plants, and ultimately indeed on the special characteristics of the soil itself. Medical science will not lose, but gain, by Prof. Topley's transference to the wider field of agricultural science.

Centenary of the Pharmaceutical Society

IN the afternoon of April 15 several hundreds of pharmacists attended a meeting at Conway Hall, Red Lion Square, London, which was held to celebrate the centenary of the Pharmaceutical Society. Mr. Walter Deacon, who presided, introduced Sir John Anderson, Lord President of the Council who, he said, now had many dealings with representatives of the Society at the Home Office and elsewhere. In his address, Sir John said it was fitting that someone with a knowledge of the circumstances of pharmacy extending over thirty years should attend the meeting as a representative of His Majesty's Government to pay tribute to the Society's past achievements and to wish it well for the future. The founders of the Society, he continued, laid down that its main purpose should be to advance chemistry and pharmacy, and the constancy with which their successors had pursued that aim deserved the fullest recognition. Modern developments of medicine have changed completely the work of the pharmacist, and it is right that the public should now know how successful have been the efforts of the Pharmaceutical Society to

keep in line with the advance in knowledge and the great progress of medical science. A play, "Jacob Bell and Some Others", specially written for the occasion by Mr. H. N. Linstead, secretary of the Pharmaceutical Society, and produced by Donald Wolfit, followed the speeches. It brought vividly to the large audience episodes associated with the Society's foundation.

Haricot Beans

At the request of the Ministry of Agriculture the Imperial Bureau of Horticulture and Plantation Crops, East Malling, has issued a bulletin compiled by G. St. Clair Feilden, on haricot beans (Occasional Paper No. 6. 1*s*.). Hitherto cheap supplies of beans from North America, Japan and Hungary have discouraged farmers in the United Kingdom from embarking on a crop that proves only fully successful in a dry summer. In war-time, however, it seemed advisable to re-examine the possibility of providing such a valuable addition to the nation's food, and yields of one ton or more per acre were obtained in trials made in 1940. The bulletin contains a brief account of work with haricots in the United States and Canada and of the results of experiments in England at various centres. Cultivation is outlined and harvesting and cooking methods are described. The varieties at present available, though they did well in England in 1940, are really more suited to warmer and drier climates, and it is to be hoped that some growers will become sufficiently interested to hybridize and select strains that are more dependable to ripen a full crop in Great Britain.

War Fellings and Insect Pests

In the *Scottish Forestry Journal* (**54**, Pt. 2, Oct. 1940), Dr. A. E. Cameron, of the Department of Entomology, University of Edinburgh, writes on "The Effect of Felling on the Incidence of Forest Insect Pests". The many fellings throughout Britain during the War of 1914–18 and the remnants left on the ground for several years thereafter were the breeding places of large numbers of some of the more dangerous of our insect pests, which afterwards spread destruction in young, middle-aged, and old woods throughout the country. Once again we are faced with a similar emergency, and the same aftermath of the fellings is to be seen on many a site of a former wood, now felled for war purposes. The insect pest question, as Dr. Cameron says, is likely to be acute in the near future unless attention is given to it, and some effort made to counter its possible or certain virulence. The author practically confines himself to conifers and their chief pests. But in parts of Great Britain there is an equal danger to some of the valuable hardwoods, including oak, ash and elm, to mention three only. But since the major part of the afforestation work of the Forestry Commission is connected with the conifers, the question of this possible insect danger is greater now than it was in 1918, when there was a comparatively small area of young conifer plantations in the country.

Dr. Cameron deals with the different types of forest and their respective immunity or otherwise. He says that our only indigenous conifer, the Scots pine, is the most subject to attack by several species, but that the other conifers, exotics, such as spruce, Douglas fir and larch are subject. The chief dangerous pests are the weevils, *Hylobius abietis*, *Pissodes notatus* and *P. pini*, and the pine beetles, *Myelophilis piniperda* and *M. minor*, *Hylastes ater* and *Pityogenes bidentatus*. In order to combat these pests, Dr. Cameron states that their habits must be known intimately, and then some measures of control which he details may be instituted.

Anthropological Observations in New Guinea

Information relating to the work of an expedition of anthropological, ethnographical and linguistic investigation in the little-known north-eastern region of New Guinea under the leadership of Dr. Georg Höltker is given by Dr. Otto Schlaginhaufen in the current issue of the bulletin of the Swiss Anthropological and Ethnographical Society (*Bull. Schw. Gesell. f. Anthrop. u. Ethnol.*, **16**, 1940). The expedition, which had recently returned at the time of writing, was in the field for the three years 1936–39. Its operations covered the coastal region south-eastwards from the mouth of the Sepik River, and the coastal and inland territory on the east side of the lower waters of the Ramu River, and country in the basin of the Mbur, a tributary of the Ramu, as well as islands of the coast including Manam and Dampier. Of the peoples under investigation by the expedition a proportion were classifiable linguistically as belonging to the Melanesian stock, but the greater number were Papuan. Anthropological observations were made by Dr. Höltker on members of the former group on the mainland—Sepa and Wanami living to the south of the coastal peoples of Monumbo (Potsdamhaven) and on the islands. The Papuan group examined included the Bosgung on the Mbur, Watum to the south of the Sepik and among inland peoples, Tanggum, Ariaw, Mikarew, Dinam and Akekom. Observations were made on 1,685 individuals, both adults and children.

Earthquake in Mexico

A severe earthquake shook more than 20,000 square miles of territory in northern Mexico on April 15, causing much damage to property, and, it is feared, a heavy death roll. Full details are as yet lacking, but preliminary facts may be given. The States most affected were Aguascalientes, Colima, Guanajuato, Jalisco, Mexico, Michoacan, Puebla and Tlaxcala, the isoseismals apparently being elongated in an east-west direction. The epicentre may have been in the neighbourhood of Chilpancingo, though very great damage was done to the city of Colima, capital of the State of Colima, 275 miles west of Mexico City. In Colima the homes of approximately 10,000 people have been reported destroyed. There were damage and loss of life also at other towns, including Guadalajara and Manzanillo, and as far east as Maltrata in the State of Vera Cruz. Mexico

City was only slightly affected. At the same time, the volcano near Colima erupted, setting fire to forests. These fires further threatened Colima.

Recent Earthquakes recorded at Kew

FOUR large earthquakes have been recorded at Kew in the period March 23 – April 13. The first was received at 22h. 41m. 17s. G.M.T. on March 28 and may have been from an epicentre 19,000 km. distant, though the initial movements were confused by microseisms. The second was at 10h. 52m. 19s. on April 1, probably from an epicentre 7,870 km. distant, while the third, at 15h. 34m. 31s. G.M.T. on April 3, had its epicentre 9,180 km. away. This latter had a particularly prominent wave on all three components at 15h. 33·5m. G.M.T., which may have been *eSSS*. An earthquake giving a full suite of pulses had *iP* dilatational at 23h. 40m. 27s. G.M.T. on April 7 and did not cease recording until 3h. 20m. G.M.T. on April 8. It probably had its epicentre 7,920 km. distant from Kew, though all calculated epicentral distances are tentative.

Canadian Polar Year Expeditions

THE first volume of a work which describes the observations carried out by the Canadian Polar Year Expeditions, 1932–33, is largely statistical; but there is a general introduction by Dr. J. Patterson, the director of the Canadian Meteorological Service, and notes on the instruments at the Expeditions' four stations—Cape Hope's Advance, Chesterfield Inlet, Coppermine and Meanook, together with maps and photographs (Dominion of Canada: Department of Transport, Air Services Branch, Division of Meteorological Services of Canada. Canadian Polar Year Expeditions, 1932–33, Meteorology: Cape Hope's Advance, Chesterfield Inlet, Coppermine, Meanook. Vol. 1. Pp. xvi + 443 + 46 plates. Ottawa: King's Printer, 1940). Meanook (Alberta) is a permanent magnetic station—the nearest to the north magnetic pole—the other three stations were temporarily set up for this undertaking. The statistical matter which, as has already been mentioned, occupies a very large proportion of the volume, consists mainly of hourly values of atmospheric pressure, temperature, humidity, precipitation, sunshine and wind velocity, to which are added full particulars of the upper winds revealed by numerous observations with pilot balloons, and notes on optical phenomena. The period covered—August 1932–September 1933—is long enough to illustrate the inhospitable climate of these regions, with frequent gales and strong winds, and a long and severe winter. The complete absence of trees, and even of bushes, worthy of the name, at the more northerly stations needs no other explanation.

At Coppermine, pilot balloon observations were supplemented by seventy-four soundings with kites carrying Marvin meteorographs lent by the U.S. Weather Bureau, but the results do not appear to be given in this volume. The same station was supplied with several Patterson flashing-lamp balloon meteorographs. This is a very light form of meteorograph which indicates pressure and temperature by the lighting up of a string of electric bulbs suspended by a silk cord beneath the balloon, an observation consisting of the identification of the bulbs shining at a particular moment. Graphs of temperature observations up to 2 km. obtained in this way in March 1933 are given, all of which show at least one inversion or disappearance of lapse of temperature with height, below 1 km. At Meanook, the most southerly of the four stations (54° 37′ N.), noctilucent clouds of the kind described by Störmer were observed on the night of July 20–21, 1933, at a height exceeding 55 km. This appears to be the first occasion on which such clouds have been noted in America.

A Plastic for Thermal Insulation

IN the electrical industry cellulose acetate is widely used in both sheet form and as mouldings. A multilayer insulating material, made from cellulose acetate, and known as 'Isoflex', is described in the *Electrician* of March 7. Isoflex is manufactured from cellulose acetate film and in structure is not unlike corrugated cardboard used for packing purposes, with about five layers to each inch of thickness. It has a thermal conductivity of 0·32 B.TH.U. per hour per sq. ft. per in. thickness per 1° F. difference of temperature, so that its insulation properties compare very favourably with slab-cork (0·25 B.TH.U.), glass-fibre (0·28 B.TH.U.) and wood fibre board (0·38 B.TH.U.). Its volume weight of 0·75 lb. per cu. ft. works out at about one-tenth that of slab-cork. This makes it of considerable interest in connexion with thermal insulation during transport.

Isoflex is non-porous and non-absorbent, with the result that its thermal insulation is not impaired by the deposition of moisture in the material. Its construction in the tubular form allows free draining of condensed moisture. From the constructional point of view it is very easy to handle, as it can readily be cut by a knife. It will withstand wear and tear, and it does not disintegrate under the severe vibration of a railway coach; it is inert to salt water, thus making it suitable for marine work. It will not ignite or burn by itself, and therefore its installation does not result in an increase in the fire risk. However, it melts at about 175° C. and it is not suitable for heat insulation at temperatures which exceed 75° C. Isoflex is available in two types of slab. One type, known as the standard slab, is 24 in. square and is rigid; the other, the flexible slab, measures 23 in. × 20 in. By cutting one or other of these slabs, and by using a combination of them, any desired shape can be built up without difficulty.

Electric Supply in Churches

THE eighth report of the Central Council for the Care of Churches includes a timely memorandum for the guidance of parochial authorities about to install new lighting apparatus, and a series of regulations to be observed by contractors. In a preface to the regulations is a statement that the work must comply with the regulations of the Institution of

Electrical Engineers. Cables must be rubber- or paper-insulated and must be run in heavy-gauge solid-drawn galvanized-welded screw conduit (preferably) or in heavy-gauge welded screw conduit. Alternatively, 'Pyrotenax' may be employed. Attention is directed to a modification of an electric soldering iron for heating sealing compound, which enables joints to be made on the spot instead of entailing removals to a bench for heating with a blow lamp, in order to avoid risk of fire where timber is adjacent.

Cables of the supply undertaking should be taken into the building for as short a distance as possible and run only on brick or stone walls. Distribution boxes and fuses must be in cast iron cases. Instrument panels should be well clear of walls and should be of slate or other non-inflammable material; if of wood, only teak may be used. The wiring of ancient brass candelabra is condemned, as it would be almost impossible to remove the detachable brasses for cleaning. Electroliers or fittings must be hung on chains and their weight must not be borne by electric cables or flexible cords. All reachable metal work is to be earthed. Any relay or other circuit carried to a switch at an organ keyboard for starting a blower must be run in screwed conduit or be of 'Pyrotenax'; the starting switch must be in a metal case mechanically and electrically continuous with the circuit and with the approved earth connexion.

American Philosophical Society Publications

THE American Philosophical Society has issued a list of books and papers in the Society's publications from 1769 until 1940 classified according to subject. This covers the papers, monographs, treatises and books, classified according to subject, and includes a subject index as well as a classified list, an author index and a price list. The *Transactions* of the Society is the oldest scientific journal with a continuous history in the United States, commencing in 1769; the six volumes issued in small quarto format up to 1809 are known as the "old series" and are out of print except for a few numbers. A new series was started in the present large quarto format in 1818, and to date thirty-one volumes have been issued.

The *Proceedings*, commenced in 1938, contain the original papers read before the Society as well as others accepted for publication. In view of the interest and value of some of the early material to the research student and historian, certain abstracts of papers read before the Society, verbal communications, letters on scientific and learned subjects, etc., included in the early *Proceedings* have been reproduced in the list. The *Memoirs*, commenced in 1935, consist of monographs and books each constituting a separate volume of the series, of which fifteen volumes have now been issued. In addition to its serial publications, the American Philosophical Society has published or sponsored for publication a number of separate works which are listed under "Miscellaneous Publications". Its library also maintains a photo-duplication service for supplying 35-mm. microfilm copies of out-of-print articles and manuscript material. Printed books are copied at the rate of 3 cents per standard frame, usually 2 pages per exposure. Manuscript is copied at the rate of 4 cents, usually 1 page, per exposure.

The Night Sky in May

THE duration of night (sunset to sunrise) decreases from 9·3 hours on May 1 to 7·7 hours on June 1 in the latitude of London. Full moon is on May 11 and new moon on May 26. No bright star is occulted by the moon during the month. There is a general absence of bright planets in the night sky of this month. Jupiter and Saturn are now too near the sun for observation. Towards the end of May, however, conditions are favourable for seeing Mercury in the low western sky after sunset. In mid-May, Mars is nearly 5° above the eastern horizon soon after 3h. 30m. U.T., but sunrise is shortly after 4h. (add 2 hours to convert to new Summer Time). About this date the following constellations are near the southern meridian at dusk: Ursa Major, Canes Venatici, Coma Berenices, Bootes, Leo, Virgo, Crater, Corvus and Hydra. Pleasing in its symmetry is the formation of seven stars of medium brightness in Corona Borealis. A nova appearing near ε Coronæ Borealis in 1866 added to the lustre of this 'crown'.

University of Birmingham: Air Raid Damage

IN a recent air raid, many bombs fell in the grounds of the University of Birmingham, and the chemistry buildings were hit. Fortunately, very little damage was done.

Civil List Pensions

A LIST of the pensions granted during the year ended March 31, 1941, and payable under the Civil List Act, 1937, has recently been issued. Among them are the following: *New Pensions:* Mrs. Mary Browne (services of her husband, the late Dr. Charles Browne, to anthropology), £100; Dr. C. C. Hurst (discoveries in science of genetics and their application to agriculture, horticulture and sociology), £130; Sir Alfred Matthews (services to agriculture), £150; *Supplementary Pensions:* Mrs. Jessie Bennett (services of her husband, the late Mr. Arthur Bennett, to botanical science: additional to £60), £40; Miss Fanny Bryant (services of her father, the late Mr. Thomas Bryant, to surgery: additional to £30), £70; Mrs. Barbara Kaye (services of her husband, the late Mr. Walter J. Kaye, to archæology: additional to £60), £40; Mrs. Johanna Miller (services of her husband, the late Dr. N. H. J. Miller, to agricultural science: additional to £50), £50; Miss Eleanor S. Sowerby (botanical works of her father, the late Mr. J. E. Sowerby: additional to £50), £50; Mrs. Elsie V. Sullivan (services of her husband, the late Mr. J. W. N. Sullivan, to literature: additional to £75), £25; Miss Helen S. Tichborne (scientific discoveries of her father, the late Prof. Tichborne, in chemistry and pharmacology: additional to £60), £40; Mrs. Ada E. Scott (services of her husband, the late Mr. Andrew Scott, to zoological science: additional to £80), £30.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

IN THE PRESENT CIRCUMSTANCES, PROOFS OF "LETTERS" WILL NOT BE SUBMITTED TO CORRESPONDENTS OUTSIDE GREAT BRITAIN.

Ionization Maximum for Protons

IN a recent paper, Holloway and Moore[1] have given a curve showing the average specific ionization, as a function of the residual range, for protons in air. On this curve the ionization maximum occurs at 1·9 mm. residual/range, and in the course of the paper the absolute value of the maximum specific ionization is quoted as 2,320 ion pairs per mm. The shape of the ionization/range curve was deduced from earlier measurements of Parkinson, Herb, Bellamy and Hudson[2], and the absolute value of the ionization was obtained on the assumption that, in the region of 3 cm. residual range, the mean specific ionization produced by a proton is a quarter of that produced by an α-particle of the same velocity. On this basis Holloway and Moore inferred that the maximum specific ionization is about one third as great for protons as for α-particles in air (6,760 ion pairs per mm.). Now, while there is overwhelming evidence for the correctness of this last assumption (the 1 : 4 ratio of ionizations for particles of the same velocity, when the ratio of the effective charges is constant at 1 : 2), it also appears that the conclusions, regarding the position and height of the ionization maximum for protons, to which the subsequent argument leads, run contrary to accepted evidence from other experiments. If this be admitted, then one must clearly assume that the results of Parkinson, Herb, Bellamy and Hudson will not bear the detailed analysis which Holloway and Moore place upon them, when protons of the smallest energy are concerned. It is the object of the present note to point out the contrary evidence referred to above.

As regards the position of the ionization maximum, the situation is relatively simple: this has been determined by Bower[3] from observations of the light scattered by cloud tracks of protons in a mixture of helium and air. Bower found a maximum in the scattered-light/distance curve at a point corresponding to 0·8 mm. residual range in standard air. While the method is quite different, and the definition of the end of the range not necessarily the same as in ionization chamber experiments, the discrepancy (0·8 as against 1·9 mm.) is greater than can be explained by such considerations. It can only be resolved by assuming that the velocity at which electron capture by protons becomes appreciable is much less in helium than in air. On the other hand, if we are to accept an increase in the assumed value of the maximum ionization (*v. inf.*), then the suggestion of a lower effective charge over the last few millimetres of residual range in air is clearly unwarrantable.

There are two distinct lines of evidence concerning the absolute value of the maximum specific ionization by protons which Holloway and Moore do not mention in the paper under discussion. In the first place, the experiments of Parkinson, Herb, Bellamy and Hudson provide some information which has still to be considered. In the α-particle case Holloway and Moore deduce the energy/range relation, for small values of the residual range, by integrating the differential specific ionization curve of Holloway and Livingston[4] and assuming a constant value for the average expenditure of energy per ion pair, for α-particles of all ranges. With protons, however, they deduce the shape of the differential ionization curve from the results of Parkinson *et al.*, while these results, in themselves, are believed to express the energy/range relation down to the smallest energies. Normalizing the differential curve against the corresponding curve for α-particles, as already described, Holloway and Moore obviously assume the same energy loss per ion pair for the two particles at high energies, yet for low energies a comparison of their differential-ionization/range and energy/range curves shows an apparent rapid increase of this mean energy loss for protons, as against the assumed constancy of this quantity for α-particles. Over the last 2–3 mm. of path, the energy/range relation gives an average rate of loss of energy almost exactly 10^5 ev. per mm. for protons in air (see Bethe[5]); if the differential ionization curve of Holloway and Moore were correct in this region, an expenditure of about 53 ev. per ion pair would be required. To set against this conclusion, for protons of about 8 mm. air range, a direct determination by Stetter and Jentschke[6] gave $32{\cdot}6 \pm 1{\cdot}6$ ev. per ion pair (in deuterium), compared with the accepted value of 33 ev. for α-particles of some cm. range.

The second line of evidence for a higher ionization maximum for protons derives from experiments on the photo-protons produced in deuterium by the γ-rays of thorium C″. Rogers (F. T.) and Rogers (M. M.)[7] have determined the mean energy of these protons as $(2{\cdot}25 \pm 0{\cdot}15) \times 10^6$ ev. from experiments with a cloud chamber in a strong magnetic field. Direct determinations of the mean number of pairs of ions produced by the photo-protons in deuterium have been made by Chadwick and Goldhaber[8] ($7{,}200 \pm 1{,}000$) and, more accurately, by Stetter and Jentschke[6] ($6{,}650 \pm 200$). From the measurements of Chadwick, Feather and Bretscher[9], Bethe[5] has calculated the mean air range as 2·28 mm. From these figures, again, the average expenditure of energy per ion pair in deuterium is $33{\cdot}8 \pm 2{\cdot}6$ ev., the same as for high-energy α-particles, and, if one takes this value for protons in air also (for high-energy α-particles the energy loss per ion pair is almost exactly the same in air as in hydrogen) then the mean ionization per mm. due to protons in air

(over the last 2·28 mm. of path) is 2,900 ± 230 pairs of ions. If this be accepted, the maximum specific ionization cannot well be less than 3,400 ion pairs per mm. or one half, rather than one third, of the maximum specific ionization due to an α-particle.

N. FEATHER.

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March 21.

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[5] Bethe, *Phys. Rev.*, **53**, 313 (1938).
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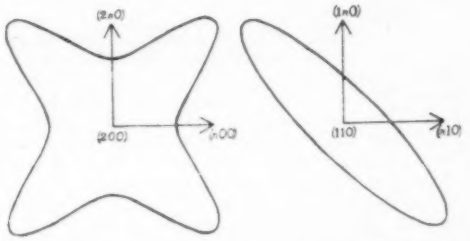
Diffuse Reflexion of X-Rays

In a recent note Preston[1] has commented upon the agreement of his experimental results for the diffuse scattering of X-rays by single crystals of aluminium with the predictions of both the Preston–Bragg block hypothesis and a formula derived by Faxén. It seems necessary to correct the impression which might thereby be formed that the Preston–Bragg hypothesis is reconcilable with the Faxén–Waller theory. This is indeed not the case. It has been shown by Laue[2] that if the intensity of scattering from a finite crystal is plotted in the reciprocal lattice space as a function of the end-point of the vector $\vec{S} = \frac{\vec{\varepsilon} - \vec{\varepsilon}_0}{\lambda}$ ($\vec{\varepsilon}_0$, $\vec{\varepsilon}$ unit vectors in the direction of incident and reflected ray, λ wave-length) drawn from the origin of the reciprocal lattice, then the resulting distribution of scattering power is periodic with the periods of the reciprocal lattice, so that in particular there is the same distribution about every reciprocal lattice point. On the other hand, the Faxén formula discussed by Preston is obtained by specialization (see below) from a general expression derived by both Faxén[3] and Waller[4] for the first approximation to the coherent diffuse scattering from a monatomic cubical crystal. This general expression can be written in the form:

$$I \sim \frac{(\vec{S}, \vec{A}_1)^2}{\nu_1^2} + \frac{(\vec{S}, \vec{A}_2)^2}{\nu_2^2} + \frac{(\vec{S}, \vec{A}_3)^2}{\nu_3^2},$$

where $\vec{A}_1$, $\vec{A}_2$, $\vec{A}_3$ are unit (and orthogonal) vectors defining the directions of oscillation of those three acoustical vibrations the wave vector $\vec{w}$ of which satisfies the Faxén-Waller vector condition (namely, $\vec{w} = \vec{S} - \vec{B}$, where $\vec{B}$ is that reciprocal lattice vector the end-point of which lies nearest to that of $\vec{S}$) and ν_1, ν_2, ν_3 are the respective frequencies of these vibrations. Owing to the occurrence in this expression of the cosines of the angles between the vector $\vec{S}$ and the vectors of oscillation, it is clear that the expression must lead to a different distribution of scattering power about each point of the reciprocal lattice. In a paper which I have in preparation, the general Faxén–Waller expression has been evaluated for various relative values of the three elastic constants c_{11}, c_{12}, c_{44} of a cubic crystal, and the marked dependence of the scattering power upon the elastic anisotropy demonstrated. For example, for sodium single crystals, using the values of the elastic constants determined by Quimby and Siegel[5], namely, $c_1 = 0{\cdot}760\ c_{11}$, $c_{44} = 0{\cdot}914\ c_{11}$ (at 200° K.), with cubic anisotropy $c_{11} - c_{12} - 2c_{44} = -1{\cdot}59\ c_{11}$, the section of the contours of isodiffusion for the 200 and 110 reflexions in the 200,020 plane of the reciprocal lattice approach, in the limiting case of long elastic waves, that is, proximity to the Bragg spot, the shape shown in the accompanying diagram.



THEORETICAL CURVES OF ISODIFFUSION FOR SODIUM SINGLE CRYSTALS.

Experiments to test the existence of these different distributions about different Bragg spots are being carried out in this Laboratory, although it should be pointed out that the earlier work of Laval[6] gives clear indication that these differences do exist in the manner required by the Faxén–Waller theory.

The special assumptions made by Faxén in arriving at the simple formula discussed by Preston included that of spherical isotropy for the elastic properties of the cubical crystal, namely, the relation $c_{11} - c_{12} = 2c_{44}$, which condition is fairly closely satisfied by aluminium ($c_{12} = 0{\cdot}57\ c_{11}$, $c_{44} = 0{\cdot}26\ c_{11}$, $c_{11} - c_{12} - 2c_{44} = -0{\cdot}09\ c_{11}$); consequently the differences here will be less marked and more difficult to determine.

It should be stressed that we have in the diffuse scattering phenomenon a much finer method of exploring the vibrational spectrum of a crystal than is possible by studying, for example, the specific heat or the Debye–Waller factor; for whereas there one is dealing with averages over all directions of propagation of the elastic waves, here, in the diffuse scattering for a given crystal setting and direction of scattering, only those vibrations the wave-lengths and directions of propagation of which lie within restricted limits contribute to the scattering (Faxén–Waller vector condition).

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April 2.

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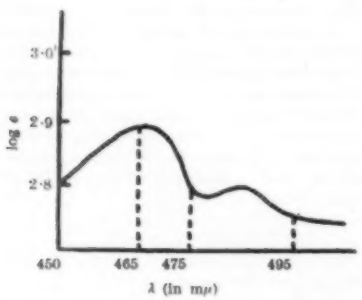
Formation of Ions from Compounds with Conjugated Double Bonds: Hydrocarbon Salts

IT has been suggested previously[1] that any system containing conjugated double bonds should be capable of forming ions, particularly positive ions. This holds not only in the case of carbon-carbon bonds (aliphatic or aromatic) but also in systems containing, for example, nitrogen, oxygen, sulphur, which, like carbon, can supply mobile π-electrons (double-bond electrons) which are essential for the 'metallic' behaviour of these compounds. Particular interest is attached to the hydrocarbons with conjugated rings, to which group the carcinogenic hydrocarbons also belong.

I have now succeeded in preparing various salts from these hydrocarbons such as coronene, 1 : 2 benzperylene, 3 : 4 benzpyrene, and anthracene with different acids (perchlorate, sulphate, pyrophosphate) as anions. As indicated earlier[1] these salts are formed from the hydrocarbons by an oxidizing agent, such as a chromium trioxide, potassium ferricyanide or hydrogen peroxide, in the presence of the fairly concentrated strong acids at room temperature. Many of these hydrocarbons are oxidized even by molecular oxygen, yielding the same oxidation products. The sulphates are more difficult to prepare because conditions must be found where no appreciable sulphonation of the hydrocarbons takes place. However, it seems that deeply coloured (water-soluble) salts are formed even from the sulphonated hydrocarbons.

The perchlorate of anthracene is the lowest of the series which has been prepared so far. It shows some of the characteristic properties of these new compounds, which are given in the following:

Anthracene perchlorate, $[C_{14}H_{10}]^+[ClO_4]^-$. Found: C, 60·9; H, 3·2; Cl, 12·5; $C_{14}H_{10}ClO_4$ requires C, 60·6; H, 3·6; Cl, 12·8 per cent; dark brown fine crystals, recrystallized from acetone-methyl alcohol (1 : 1) decomposes before melting above 110°. Very soluble in acetone with deep brown colour (absorption spectrum, see below). The solutions in acetone are good



ABSORPTION SPECTRUM IN THE VISIBLE REGION OF ANTHRACENE PERCHLORATE IN ACETONE SOLUTION.

conductors of electricity. Electrolysis takes place and a deposit is formed at the cathode. Also soluble in ethyl alcohol and benzene. Whereas the salts of the higher molecular hydrocarbons are stable in the presence of water, anthracene perchlorate is decomposed by water, particularly in solution. The perchlorates are all easily decomposed by heat.

The deep colour of the solutions is due to the positive hydrocarbon ion, as is to be expected on theoretical grounds. Under the conditions studied, monovalent ions have been observed ([hydrocarbon]+ [anion]−), although the formation of divalent hydrocarbon ions does not seem unlikely in certain cases.

We have further been led to investigate the structure of the well-known hydrocarbon polynitro compounds (for example, hydrocarbon picrates). These compounds have hitherto been regarded as 'polarization aggregates', although Hammick[2] and Gibson and Loeffler[3] have already suggested that an 'electronic shift' takes place in the case of the corresponding amino compounds. On the basis of the above considerations, we have come to the conclusion that these deeply coloured polynitro compounds are present to an appreciable extent as ionic compounds of the general formulæ: [hydrocarbon]+[nitro compound]− and [amino compound]+ [nitro compound]− in those cases were the molecular ratio is 1 : 1 or as divalent ions; for example, [hydrocarbon]++ [nitro compound]$_3^{2-}$, where the molecular ratio 1 : 2 prevails. This explains their deep colour, and the rates and mechanism of their formation and decomposition, and is compatible with the observed heats of formation.

The crystal structure of these compounds and the crystallographic distances (3–3·5A.) between their constituents can now be easily explained on the basis of ionic crystals of a somewhat salt-like character as discussed above. The sodium chloride type of structure has actually been observed in the system acenaphthene - 2,6-dinitro - 1,3-xylene[4] whereas in many other cases[5] we find the 'layer lattice' type, as is to be expected when the ions differ appreciably in their size and polarizability.[6]

The importance of these ions is not confined to their appearance as intermediate products in various reactions concerning conjugated systems (oxidation, polymerization, etc.) but may open new possibilities in organic synthesis and give a deeper understanding of their biological action.

A full report will be published elsewhere.

I wish to express my thanks to Prof. G. R. Clemo, and Prof. J. W. Cook for valuable discussions and specimens of hydrocarbons.

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VEGETABLES AS FOOD

By Dr. Magnus Pyke

THE low mechanical efficiency with which a steam engine converts heat into energy is perennially shocking to each generation of schoolboys, but the wastefulness of the steam engine is nothing compared with the waste of vitamin C which takes place between the time a green vegetable is harvested and its final disappearance from the diner's fork. A cabbage bought at the market may perhaps be expected to contain 60 per cent of its original vitamin C content, the housewife probably throws away no more than 20 per cent of the remainder in preparing the vegetable for the pot, leaving 40 per cent of the original vitamin. During boiling, however, although a negligible proportion is destroyed by the heat, about 65 per cent is extracted by the cooking water and usually thrown away. Thus 17 per cent of the vitamin C with which the cabbage left the field is all that remains when it reaches the table, and if the dish is kept hot before being served even this small residue quickly dwindles to extinction. In 1940, one and a third million tons of green vegetables were produced in Great Britain. From this crop roughly 650,000 kilograms of ascorbic acid, or almost exactly the amount needed to satisfy the physiological requirements of the entire population for a year, was lost.

To the canner it would be thought was presented the opportunity of stopping at least some of these great losses. For him there is the minimum delay between harvesting and processing. The crops are grown to suit him so that loss in preparation for cooking must be small. Cooking, one would think, was inside the tin so that the principal loss by extraction could be avoided. However, the canner, it seems, must do what he should strenuously eschew. He plunges his vegetables for 1½–20 minutes into nearly boiling water before he puts them in their tins and thereby loses the bulk of the vitamin C. Blanching, he calls it, and advances five technological reasons for doing it: but what a pity!

It was at the discussion on April 9 of the nutrition panel of the Society of Chemical Industry on "Vegetables as Food" that these points arose. Miss Mamie Olliver reported one experiment after another of her own unpublished work showing the devastating effect of cooking on the vitamin C in vegetables, and Mr. W. B. Adam concluded that canning affects the nutritive value of vegetables equally as domestic cooking.

Although root vegetables may provide carbohydrate, and green leaves supply protein of useful quality, and although pulses contribute calories, carbohydrate and second-class protein to the diet, vegetables are primarily useful as sources of vitamins A and C and iron and calcium. If the proportions of the day's requirements of each of these four factors in 4 oz. of any vegetable, cooked or raw according to how it is customarily eaten, are plotted one above the other as a column in a graph, a measure of the excellence of the article as a protective food is obtained. A series of vegetables graded in this way and arranged in order of merit is instructive. First come the green vegetables, broccoli tops, watercress, mustard and cress, Brussels sprouts and spinach, rich in carotene, very rich in vitamin C, and containing useful contributions of iron and calcium, although it is doubtful whether the calcium in spinach is utilizable. Next come cabbage and cauliflower, which still contain substantial amounts of vitamin C but negligible quantities of carotene. In green vegetables carotene is associated with greenness; when the heart of a cabbage is blanched it thereby forfeits its rank in the highest class of 'protective' vegetables. Tomato and lettuce fall in the middle of the list. They contain more carotene but much less vitamin C. The vegetables at the bottom of the list, one-fifth as concentrated as the greens, are turnips, green peas, radish, leeks, parsnips, string beans and onions. Asparagus, cucumber, celery and marrow contain so little of vitamins or minerals that they cannot be graded at all.

How does the carrot stand in such company? Carrots contain carotene, but I have presented figures which showed that although 4 oz. of boiled carrot contains as much carotene as the same amount of boiled Brussels sprouts, this was less than half that in spinach, watercress or broccoli. Carrots besides possess a mere 5 per cent of the vitamin C in the green vegetables and a fraction of their available iron and calcium. Even Dr. Leslie Harris, who asserted that the carotene in carrot can equal or excel that in the best green vegetables, cannot thereby promote it to a rank of equality with them in general excellence as a protective food.

The leading vegetable of all those mentioned at the discussion was 'broccoli tops'. McCance, Widdowson and Shackleton introduced the name to the scientific world when they analysed their samples in 1936, but agriculturists, even guided by a botanical designation, found the term ambiguous. Five London greengrocers approached during an interval in the discussion under review produced three different plants identified respectively as 'purple sprouting broccoli', 'white broccoli' and 'winter cauliflower'. Miss Widdowson expressed the belief that none of these was the 'broccoli tops' reported upon in the literature.

In planning war-time vegetable production there is more to do than identify and grow the crops of highest nutritional value. Yield per acre, hardiness and popularity must all be considered. Cabbages which produce heavy crops are tolerated by the public. Brussels sprouts are liked. Although education and shortage can drive people part of the way towards eating what they do not like, palatability is nevertheless important.

Dr. H. V. Taylor showed how war-time vegetable production has been organized to comply with the suggestions of the Scientific Food Policy Committee. A supply of green vegetables has been assured all the year round, the acreage of carrots has been doubled, greenhouses devoted in peace-time to the growing of flowers have been converted to tomatoes and so on. Now, however, the army, the navy, the air force and the general public are insistently crying out for a vegetable product of negligible dietetic

value, namely, pickles. In 1941, therefore, it has been decided to plant several thousand acres of land with onions for pickling, with garlic, cauliflower, gherkins, red cabbage and mustard. Will science say that the decision is wrong ?

When the figures are compared side by side, green vegetables are more substantial providers of vitamin C than any fruit except black currant. Thus in war-time they can readily take the place of the oranges and lemons which no longer reach us. According to the analytical figures for carotene, besides supplying the full physiological requirement of vitamin C, green vegetables can also provide all the vitamin A we need. Here is, however, a topic on which further investigation is required. To what extent is the carotene present in each plant physiologically active as vitamin A, and what proportion is absorbed by the body ? Even if only 40 per cent of the carotene present in a 4-oz. portion of watercress is physiologically available, it will still provide 50 per cent of the total daily requirement. In spite of the lack of clear-cut evidence on the vitamin A activity of each vegetable, there are, therefore, grounds for asserting that the full vitamin A needs of the body could be supplied by vegetables should circumstances ever require it.

Besides their importance as protective foods, vegetables could play other minor parts in war-time nutrition. A temporary glut of carrots, for example, if dried would provide palatable carbohydrate. Although perhaps more physiological work is needed on the biological value of green leaf protein, Sir John Russell, from the chair, agreed with the weight of current scientific opinion that its value is high. Preparation of purified vegetable protein might thus provide a valuable addition to the national food supply.

The Society of Chemical Industry's discussion showed that many lacunæ in the knowledge of the nutritive value of vegetables exist. Planning of vegetable production even when guided by scientific advice is a difficult task which may never reach perfection. The crucial rôle of green vegetables is to provide almost alone in war-time the whole dietary requirement of vitamin C. Research on the physiological availability of leaf carotene is not of equal importance. Just as a population is immunized against typhoid for six months or more by a single treatment, so can a country be protected against vitamin A deficiency for a winter by a single dose. The daily requirement of vitamin C, however, must be acquired daily. This is where work, investigation, inspection and analysis at every point must be organized. The Forces equally with the civil authorities must never be satisfied with calculations from a book of tables to insure the nutritional adequacy of food supplies. The men at a mess where the best scientific information had been applied to perfect their diet were found, when submitted to a saturation test, to be grossly deficient in vitamin C. Communal catering tends to increase the times during which dishes are kept hot, a process destructive of vitamin C.

The chemists met the botanists, the dietitians and the administrators to their mutual benefit. The national interest would be served by the further penetration of scientific workers into the market, the communal feeding centre and the canteen.

THE BRITISH PHARMACEUTICAL CONFERENCE

THE seventy-eighth annual meeting of the British Pharmaceutical Conference was held at Conway Hall, Red Lion Square, London, on April 16. With a single day, instead of the best part of a week as in peace-time, the proceedings were severely curtailed, but in addition to the chairman's address, twelve papers were presented at the science session, and although only summaries of them were actually read, the full papers will be available in the official publication of the Conference, in due course. Some of the papers are outlined below.

In his inaugural address as chairman, Mr. A. R. Melhuish dealt with problems affecting pharmacists in their capacity of servants of medicine and servants of the State. He spoke, to use his own phrase, as "a workaday practising pharmacist", and advised his colleagues that they would be doing more for the medical services of the country if they devoted more attention to those fields of activity which do not involve legislation, than if they spent time in striving for such politically unattainable goals as the reservation to them of the sale of all medicines. He impressed on them the importance of 'personality'; the greatest asset for the individual pharmacist in the future, he said, would be his individuality.

Two papers related to ergot. One of them, by C. H. Hampshire and M. W. Partridge, was from the laboratory of the British Pharmacopœia Commission, and the second, by N. L. Allport and N. R. Jones, from the laboratories of the British Drug Houses, Ltd. The first consisted of notes on the extraction and decomposition of the alkaloids; it showed that neither continuous extraction of ergot with methylene dichloride nor shaking ergot with menstruum of ammoniacal acetone completely extracts the alkaloids, which are completely extracted, however, by continuous extraction with anæsthetic ether. In the second paper, the authors described a rapid method for the determination of ergometrine and ergotoxine.

A paper, by H. Berry, from the College of the Pharmaceutical Society, on the components of acriflavine, was summarized by the author as follows: (1) the bacteriostatic value of the two active components and mixtures of these in varying proportions have been compared against certain organisms; the results show little variation; (2) there is no evidence of a bacteriostatic or physical character of any definite combination between the two components; (3) it is suggested that proflavine or the neutral hydrochloride of 2 : 8-diaminoacridine should replace acriflavine for surgical use.

A second paper, by F. Wokes, from the College of the Pharmaceutical Society, had as its subject "The Subcutaneous Implantation of Thyroxine Tablets". The author suggested that great caution be employed in the implantation of thyroxine tablets in human subjects, and that preference be given to the oral administration of thyroid, which appears to be much safer and more effective.

A paper, by A. M. Briggs and D. E. Callow, from the Evans Biological Institute, dealt with the

preparation of sterile solutions of procaine hydrochloride. The author's conclusions are that sterile solutions can be prepared without the use of bacteria-proof filters, provided aseptic methods are used. Solutions prepared with an antiseptic present are not vulnerable to contamination likely to occur in a laboratory devoted to the production of sterile preparations. Solutions prepared with both an antiseptic present and an oxidation-preventive substance such as sulphur dioxide are even less vulnerable to contamination. The antiseptic properties of solutions of procaine hydrochloride tend to increase with increase of percentage strength.

A second paper, by G. E. Shaw and H. G. Hind, from the Evans Biological Institute, was on "Some Aspects of the Storage of Antitoxins During War-time". Antitoxic serum, the blood serum of hyper-immunized animals, is issued for sale either in its natural state or, more usually, as a solution of a selected protein fraction therefrom; it is of special importance in war-time owing to the exposure of the population to risk from epidemic disease and the occurrence of a large number of injuries which necessitate antitetanic treatment. Antitoxin is stored in a sterile condition at about 4° C. in large glass containers. In view of the risk from damage through enemy aerial activity, bulk storage presents a serious problem, owing to the possibility of containers breaking and the supply of electricity to the refrigerator plant being interrupted. The authors sought for a method which would eliminate the need for glass containers, and make the use of refrigeration unnecessary, but would, at the same time, preserve the potency and maintain the sterility of the product. They described two methods, each yielding a dry powder which may be stored in any type of container. The potency of the product is maintained. Cold-storage accommodation is unnecessary, and the powder is self-sterile. The desiccation method requires special apparatus for drying, but this does not involve a large capital outlay. The material contains so much preservative that, although reasonable care in handling is naturally adopted, complete asepsis is not essential.

PHOTOPHORES IN DECAPOD CRUSTACEA

DR. R. DENNELL'S work on the structure of the photophores in certain decapod crustacea from deep water is of outstanding interest and importance*. It has been known for long that luminous organs exist in many of the deep-sea decapods; but it is astonishing to find such a variety of structure and so much difference in closely related forms.

The photophores described in this work are not all proved luminous organs, but morphological evidence makes it extremely likely that this is so. Only in a few cases have live animals been seen to emit light, but those who have observed the phenomenon have made careful notes of the position of the light organs, and in these cases it is certain that true photophores are present. The reason for the luminescence is still obscure. As in the squids and fish which possess them, the luminous organs mostly throw their light downwards, lighting an area outside the field of vision, it is especially difficult to understand why in nearly all species of Sergestids examined, and also in Parapandalus, some of the photophores should be situated in such a position that they must illumine the branchial chamber and throw light downwards on the gills. There is nothing in the structure of the gills themselves to show that they could benefit from such illumination, and it may be as is suggested (but with serious objections) that the development of light-organs here is simply the response to a rich oxygen supply.

Within the genus Sergestes no fewer than four different types of photophores are found: (1) The organs of Pesta which occur in the larger number of species and are modified liver tubules of endodermal origin; (2) complex organs with lenses scattered superficially on the body which are found in *Sergestes challengeri* and its allies; (3) superficial simple organs without lenses scattered over the body as in *S. regalis* (this being an entirely new type of luminous organ); (4) simple superficial streaks on the carapace which are found to be present in those species which also possess the organs of Pesta. The second and fourth of these are of ectodermal origin, the third may be ectodermal, or, possibly, mesodermal. It is shown that the structure of the photophores in the various species of Sergestes may be entirely different and that it is unsafe to conclude that any are similar unless the minute structure is examined, even if they are in the same position.

In *Parapandalus richardi*, which with some other pandalids possesses photophores outwardly like the main bodies of the organs of Pesta of Sergestids, these organs have a totally different minute structure. It is a remarkable fact that such similar organs should have been separately evolved in the two groups; it shows that they must subserve some important function, if, as yet, not sufficiently understood. There are also in Parapandalus organs on the pleopods which are doubtfully designated as photophores.

In the Hoplophorids the photophores have reached a very high state of complexity, and here again a variety of types is shown, movement being well developed. The pleopod organs are very similar in all the species of Hoplophorus and Systellaspis examined, but the other types occur very irregularly; photophores in similar positions in two species are frequently entirely different in structure, while in a single species a number of different types of organ is to be found. For the most part the various kinds of organ are entirely distinct and they do not form stages in a developmental series. It is a remarkable fact that the luminous streak behind the fifth leg, which is a conspicuous feature in both Systellaspis and Hoplophorus, should have an entirely different structure in these two closely related genera.

The present investigation is a purely morphological one, but it is impossible to describe these organs of such unusual diversity without touching on their probable function and methods of working. The remarks made are suggestive and cry aloud for more work on this extremely interesting subject.

In conclusion, tribute must be paid to the very excellent technique and quality of the illustrations throughout.

* On the Structure of the Photophores of some Decapod Crustacea. By Dr. Ralph Dennell. Discovery Reports, **20**, 307–382, plates XXIV–XXVI (1940).

FORTHCOMING EVENTS

Saturday, April 26

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (in the Lecture Theatre of the Institute, Newcastle-upon-Tyne), at 2 p.m.—Mr. R. D. Beilby: "The Prevention of Gas-Ignition in the Overcut".

Monday, April 28

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. G. Stafford Whitby: "Chemotherapy", I.

Tuesday, April 29

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 1.30 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "The Mechanical Behaviour of Solids" (Forty-seventh James Forrest Lecture).

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 4.15 p.m.—Mr. H. H. Coghlan: "Prehistoric Iron prior to the Dispersion of the Hittite Empire".

Wednesday, April 30

PHYSICAL SOCIETY (COLOUR GROUP) (at the Royal Photographic Society, 16 Prince's Gate, London, S.W.7), at 2.30 p.m.—Mr. H. D. Murray: "Colour Terminology".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. O. R. Tisdall: "The General Practitioner and Scientific Thought".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 4.30 p.m.—Major H. C. Gunton: "Report on the Phenological Observations in the British Isles from December 1939 to November 1940".

Thursday, May 1

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Dr. Agnes Arber: "The Tercentenary of the Birth of Nehemiah Grew".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN ENGINEERING SUBJECTS—The Principal, County Technical College, Worksop, Notts. (April 30).

LECTURER IN PHYSICS AND MATHEMATICS at the Harris Institute—The Principal, Technical College, Corporation Street, Preston (May 2).

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

ASLIB War-Time Guides to British Sources of Specialised Information. No. 2: Agriculture and Allied Interests. Pp. 40. (London: Association of Special Libraries and Information Bureaux.) 5s. to Members; 6s. to non-Members. [193

Imperial Bureau of Horticulture and Plantation Crops. Occasional Paper No. 6: Haricot Beans. Compiled by G. St. Clair Felilden. Pp. 20. (East Malling: The Research Station.) 1s. [213

Brompton Hospital Reports: a Collection of Papers recently published from the Hospital. Vol. 9, 1940. Pp. v+175+24 plates. (London: Brompton Hospital.) 5s. [263

British Electrical and Allied Industries Research Association. Technical Report, Reference M/T67: Radio Interference from Thermostats in Refrigerators and Irons. By S. F. Pearce and Dr. S. Whitehead. Pp. 11+12 plates. 4s. Technical Report, Reference M/T69: The High Frequency Properties of various Forms of Wire Specimens. By G. G. Sutton. Pp. 19+13 plates. 6s. (London: British Electrical and Allied Industries Research Association.) [263

Medical Research Council: Brain Injuries Committee. M.R.C. War Memorandum No. 4: A Glossary of Psychological Terms commonly used in Cases of Head Injury. Pp. 4. (London: H.M. Stationery Office.) 1d. net. [263

The Institute of Fuel. Its Origin and Purpose, List of Council and Members as at February 1941. Pp. 106. (London: Institute of Fuel.) [263

Proceedings of the Royal Society of Edinburgh. Section B (Biology), Vol. 61, Part 1, No. 2: Non-Associative Algebra and the Symbolism of Genetics. By Dr. I. M. H. Hetherington. Pp. 24–42. (Edinburgh and London: Oliver and Boyd.) 1s. 6d. [263

Air Ministry: Aeronautical Research Committee. Reports and Memoranda No. 1888 (4207): Methods for Calculating the Frequencies of Overtones. By Prof. W. J. Duncan and D. D. Lindsay. Pp. 8. (London: H.M. Stationery Office.) 3s. net. [273

British Rubber Producers' Research Association. Publication No. 1: Elastic Recovery and Plastic Flow in Raw Rubber. By L. R. G. Treloar. Pp. 13. Publication No. 2: The Proteins of *Hevea brasiliensis*. By G. R. Tristram. Pp. 6. Publication No. 3: Fractionation of Rubber. By George F. Bloomfield and Ernest Harold Farmer. Pp. 18. Publication No. 4: The Molecular Weights of Rubber and Related Materials, 1: Experimental Methods. By G. Gee. Pp. 11. Publication No. 5: The Molecular Weights of Rubber and Related Materials, 2: Osmotic Pressure and Viscosity of Solutions of Raw Rubber. By G. Gee. Pp. 8. Publication No. 6: Relation between Molecular Weights and Physical Properties of Rubber Fractions. By G. Gee and L. R. G. Treloar. Pp. 14. Publication No. 7: Crystallisation Phenomena in Raw Rubber. By L. R. G. Treloar. Pp. 15. (London: British Rubber Producers' Research Association.) [293

Other Countries

Government of India: Department of Labour. Irrigation in India. Review for 1937–38. Pp. iii+35. (Delhi: Manager of Publications.) 1·8 rupees; 2s. 3d. [193

Queensland Forest Service. Bulletin No. 13: Fused Needle Disease and its relation to the Nutrition of *Pinus*. By H. E. Young. Pp. iv+108. (Brisbane: Government Printer.) [193

State of California: Department of Natural Resources, Division of Fish and Game: Bureau of Marine Fisheries. Fish Bulletin No. 57: The Commercial Fish Catch of California for the Years 1936–1938. By the Staff of the Bureau of Marine Fisheries. Pp. 100. (Terminal Island, Calif.: California State Fisheries Laboratory.) [193

Canada: Department of Mines and Resources: Mines and Geology Branch, Geological Survey. Paper 40–17: Preliminary Map, George Creek, Alberta. By B. R. MacKay. 10 cents. Paper 40–22: Preliminary Report—Natural Gas in Brantford Area, Ontario. By J. F. Caley. Pp. ii+31+1 map. Memoir 216: Geology of Saint John Region, New Brunswick. By F. J. Alcock. (No. 2447.) Pp. 65 (4 plates). 25 cents. Memoir 221: Geology of the Southern Alberta Plains. By L. S. Russell and R. W. Landes. (No. 2453.) Pp. iv+223 (8 plates). 50 cents. (Ottawa: King's Printer.) [213

Smithsonian Miscellaneous Collections. Vol. 100: Essays in Historical Anthropology of North America. Published in honor of John R. Swanton. (Publication 3588.) Pp. v+600+16 plates. (Washington, D.C.: Smithsonian Institution.) [213

Proceedings of the American Philosophical Society. Vol. 82, No. 5: Centenary Celebration—The Wilkes Exploring Expedition of the United States Navy, 1838–1842, and Symposium on American Polar Exploration, February 23–24, 1940. Pp. 517–950. (Philadelphia: American Philosophical Society.) 2.50 dollars. [213

Commonwealth of Australia: Council for Scientific and Industrial Research. Pamphlet No. 103: An Examination of some Australian Hardwood Charcoals, with Special Reference to their Suitability for Charcoal Gas Producers. By J. N. Almond, B. M. Holmes and Enid C. Plante. Pp. 28. (Melbourne: Government Printer.) [213

Australasian Antarctic Expedition, 1911–14. Scientific Reports, Series B, Vol. 2: Terrestrial Magnetism and related Observations. Part 3: Magnetic Disturbance at Cape Denison. By Dr. J. M. Stagg. Pp. 333–450+plates 7–14. 15s. Part 4: The Transmission of Wireless Signals in relation to Magnetic and Auroral Disturbances. By Charles Seymour Wright. Pp. 451–534. 9s. 6d. (Sydney: Government Printer.) [213

Carnegie Institution of Washington. Year Book No. 39, July 1, 1939–June 30, 1940, with Administrative Reports through December 13, 1940. Pp. xxxi + 326. (Washington, D.C.: Carnegie Institution.) [263

Svenska Linné-Sallskapets Årsskrift. Årgång 23, 1940. Pp. v+123. (Uppsala: Svenska Linné-Sallskapet.) [263

Smithsonian Institution: United States National Museum. Report on the Progress and Condition of the United States National Museum for the Year ended June 30, 1940. Pp. iii+118. (Washington, D.C.: Government Printing Office.) 15 cents. [293

Catalogues

The Hilger Non-Recording X-Ray Microphotometer. (S.B. 294.) Pp. 4. The Spekker Photo-Electric Fluorimeter. (S.B. 295.) Pp. 4. (London: Adam Hilger, Ltd.)

The Babcock Fuel Sampler. (GT.1306.) Pp. 2. The Microid Automatic Pipette (B.D.H. Pattern). (GT.1311.) Pp. 2. Reagent Bottle Drip Eliminators. (GT.1313.) Pp 2. The Metrovick Artificial Daylight Laboratory Lamp. (GT.1314.) Pp. 2. The Griffin Four-Six Clamp. (GT.1315.) Pp. 6. "Phoenix Sixty" Filter Funnels. (GT.1317.) Pp. 2. The Microid Laboratory Tube Furnaces. (GT.1318.) Pp. 6. New High Vacuum Gauges. (GT.1320.) Pp. 2. The Microid Gas Generator. (GT.1321.) Pp. 6. Price List—Catalogue 15B: Chemical Apparatus. (GT.1323.) Pp. 16. The Vacustat. Pp. 2. (London: Griffin and Tatlock, Ltd.)

The Electrophoresis Apparatus with Improved Optical System. (SB.293.) Pp. 12. (London: Adam Hilger, Ltd.)

Important Books. (Catalogue 654.) Pp. 70. (London: Francis Edwards, Ltd.)